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ABSTRACT

This document consists of test items which are applicable to biology courses throughout Australia (irrespective of course materials used); assess key concepts within course statement (for both core and optional studies); assess a wide range of cognitive processes; and are relevant to current biological concepts. These items are arranged under eight headings: (1) the organism; (2) function and structure in plants; (3) function and structure in animals; (4) integration and regulation in multicellular organisms; (5) cellular processes; (6) heredity; (7) life--its continuity and change; and (8) science and the scientific process. Also included are brief comments on and applications of the test items. (JN)

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AUSTRALIAN BIOLOGY TEST ITEM BANK

Years 11 and 12
Volume II: Year 12

Editors: David W. Brown, Jeffrey J. Sewell

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Australian Biology Test Item Bank

ACER Australian Chemistry Test Item Bank

ACER Australian Science Item Bank

Australian Biology Test Item Bank

Years 11 and 12

Volume II : Year 12

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Staff and students in over 100 independent, Catholic and state secondary schools took part in the trial testing and written evaluation of items. Without their contribution, the project could not have succeeded.

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Items were statistically analysed using the 'Itan 2' program written by Mr Lindsay Mackay and modified by Mr Stephen Farish.
We acknowledge permission from publishers to reproduce or modify material (see Appendix I).
In order to provide a more complete coverage of each concept area, a number of items published by Australian Educational authorities have been included in the Bank. These items and their sources have been listed in Appendix I. In some cases items have been modified to suit format requirements, or as a result of suggestions from teachers and interpretation of trial test data. ACER is grateful for the permission of each authority to use these items in this publication.

Introduction

The Australian Biology Test Item Bank Project

The commencement of this project in March 1982 was prompted by the need for new assessment material for Australian Year 11 and 12 biology courses. The recent increase in school-based assessment throughout Australia and the introduction of revised course statements and course materials have changed the emphasis in biology education. New assessment material was needed to meet these changes.

Dr Jeffrey J. Sewell was seconded to the ACER from the Education Department of Victoria to initiate and direct the first year's development of the Biology Item Bank Project, and later Mr David W. Brown was seconded from the same department to continue and complete the work.

The initial aims of the project were to develop a collection of items that would assist the teacher in assessment and evaluation, and be in keeping with the revised philosophies and objectives. Specifically, the items should:

- be relevant to current biological concepts
- assess key concepts within course statements, for both core and optional studies
- assess a wide range of cognitive processes
- be applicable to biology courses throughout Australia, irrespective of the course materials being used.

To assist in the achievement of the above aims, an advisory committee was formed, comprising
Dr J.P. Keeves and Dr J.F. Izard, representing the ACER
Mr M.C. Cropley, representing the Victorian Institute of Secondary Education
Mr I.C. Light, representing the Education Department of Victoria
Dr M.D. Martin, representing the VISE Biology Subject Committee
Mr D.G. Morgan, representing the Australian Academy of Science, ACT
Dr J.J. Sewell, project director 1982
Mr D.W. Brown, project director 1983–4

To ensure national representation, all states and territories were invited to contribute to the development of the Item Bank. Co-ordinators and teams in the ACT, NSW, SA, Victoria and WA were established, and contributed significantly to the overall balance of items selected. It was apparent that two distinct item types would be required: the 'traditional' **correct response** item most commonly used throughout Australia, and the **incorrect response** item used in the Year 12 external examination in Victoria. Both types have educational merit and are represented in this publication. They are distinguishable in the text by the difference in typeface.

The first year of the project saw an emphasis on the development of original Year 12 multiple-choice items, and the establishment of teams of item writers and reviewers in the ACT, SA and Victoria. With the return of Dr Sewell to teaching duties, Mr Brown completed the Year 12 material, developed the Year 11 material, and established the writing and reviewing teams in NSW and WA. Dr Sewell remained actively involved until the project was completed.

Throughout the project, practising biology educators wrote items directed towards the assessment of particular course statements. The items were then reviewed by panels of four teachers and were selected for biological accuracy, educational suitability, plausibility of distractors, and uniformity of terminology. The panels also (subjectively) assigned each item an approximate cognitive level according to 'Bloom's Taxonomy'[1]. The cognitive level assigned was that level thought to be the most appropriate skill being used by a majority of students when answering a particular item at the relevant year level. This is indicated with an abbreviation in the left hand margin of the text. The course statements used are summarized in the table of 'Concept Areas'. As the national courses revolve around major ideas or 'Concept Areas', rather than specific topics, a concept area approach was adopted. 'Concept Areas' link together to make up a particular section of study. In this Item Bank, each 'Concept Area' has a minimum of two items per hour of teaching, and there are nearly 1 500 items in the Item Bank.

Trial testing was conducted to provide empirical evidence on the items and to obtain the comments of teachers and students. It provided statistical data on the percentage of students who answered each item correctly, and on the suitability of answers and distractors. Trial testing was performed in over 100 selected government, Catholic and independent schools in ACT, NSW, SA, Victoria and WA. In order to provide a reference point for teachers using the bank, the items in Volume I were tested at Year 11, and those in Volume II were tested at

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1 Bloom, B.S. (Ed.). *Taxonomy of Educational Objectives*. London. Longmans, Green and Co. 1956.

Year 12. Year 12 items were tested in Victorian schools from August to October 1982, and in SA, the ACT and WA from July to November 1983. Year 11 items were trialled in all these states from September to November 1983. The sample sizes ranged from 75 (in two option studies) to 390, with a mean of 190. The two smallest samples were, of course, relatively small homogeneous samples of the student population. To allow for this wide range of sample sizes in the overall presentation of items, the facility levels (percentage answering correctly) are not given. Instead, all items have been assigned a level of difficulty on a scale of 1 to 5. These levels correspond to facilities as follows:

Difficulty Level	Facility Range
1	80—100
2	60—79
3	40—59
4	20—39
5	0—19

Most of the items included in the Bank after trial testing had a point biserial correlation of 0.10 or greater. The point biserial correlation provides a measure of an item's capacity to differentiate more able students from less able students as determined from the total score for the test concerned. Items with a correlation of less than 0.10 have been included where it is believed they would be of value, and are indicated by an asterisk in the left-hand margin of the text. Items which could not be included in the trial testing program have also been given an asterisk. An asterisk does not necessarily imply that an item is unsuitable in a test.

Final selection or modification of items took into account not only the statistical data but also the very constructive criticisms made by teachers and students.

Because of the enormity of the task, some overall model was needed to ensure consistency of approach and to allow for variations in emphases on core and option studies according to the various educational authorities. As the *Web of Life* materials are the most widely used resource, and these materials were modelled on the various national courses, the third edition *Web of Life* Major Idea statements provided useful guidelines. (Note that in several course sections (sections 2, 4 and 5) the Concept Area numbering in this Item Bank differs from the Major Idea numbering in the *Web of Life* course.) Although this is not an Australian Academy of Science project, it has their support. Hopefully this Item Bank will remain useful to biology educators for years to come, irrespective of the teaching materials they may use. It should also be very useful in more specific areas of biology education.

It is hoped that this Item Bank can be updated periodically. Original items may be forwarded to the address below. Notification of errors in the text would also be gratefully received. Please write to:

The Biology Test Item Bank Project,
The Australian Council for Educational Research,
9 Frederick Street,
Hawthorn, Victoria 3122

Using the Item Bank

1 Uses for the Items

A Production of diagnostic tests

A diagnostic test is one which attempts to identify learning difficulties experienced by students and enables the provision of some form of assistance in overcoming the problems that are identified. Such tests should

(a) contain a comprehensive range of items measuring the objectives of the syllabus area that is being evaluated; and

(b) enable the provision of some form of feedback to the students after they have attempted the items.

The items in the bank have been constructed so that the choice of a particular distractor will allow the teacher to determine the nature of a student's error, and to advise the student of any appropriate remedial work necessary. Common errors could be discussed in class, and written explanations of the answer (diagnostic aids) might be provided by the teacher. The format used in this publication enables teachers to select items which are most appropriate to the emphases that they have given to various topics.

B Production of achievement tests

An achievement test is a test designed to measure a student's achievement in a particular syllabus area with a single score. Just as for a diagnostic test, it should contain a comprehensive range of items measuring the objectives of the syllabus area being evaluated. As the bank includes items of a wide range of difficulty levels, it is possible to prepare tests which:

(a) discriminate very well between students in the more able section of the class (using items with a high difficulty).

(b) discriminate well between students in the weak section of the class (using items with a low difficulty); and

(c) spread the students over a wide range of marks (using items with a spread of difficulty levels with an average difficulty of about 3).

Note that difficulty levels should be used as a guide to the *relative* difficulties of items rather than as an absolute standard. The values quoted in the bank are likely to be dependent upon factors such as the nature of the students participating in the trial testing, the time of year at which testing was peformed and the emphasis placed on the topics in different schools.
It should be pointed out that the items in this collection *alone* may not be suitable for assessment of achievement, as some course objectives may be better examined using extended answer test items or practical tasks.

C Revision

Items can be set as home study for later discussion, or used in class to generate discussion. Items particularly suiting home study may tend to be of high cognitive level and high difficulty level, as these tend to promote enquiry without the time constraints of the classroom. Items suited to class discussion may tend to be of high cognitive level and relatively low difficulty level, as these may encourage contribution by a greater range of students. All students should be encouraged to select an answer before the appropriate response is revealed.

D Introduction to a topic or concept

Comprehension items with a relatively low difficulty level seem to be useful in promoting the 'discovery' of a new concept.

E Essay framework

Many items are suitable as a framework on which to construct an essay question. The alternatives may provide a series of statements which can be argued and discussed in the light of their course of study, or of the stimulus material only. Alternatively, the stimulus and stem only might be used. Suitable items would tend to have high cognitive levels (e.g. **Analysis, Evaluation**). (See Appendix II, item 1.)

F Extended response

It is a particularly useful exercise to require students to explain their reasons for choosing a particular alternative as being the answer, and for rejecting the other three alternatives. Many items with cognitive levels higher than **Knowledge** may be suitable. (See Appendix II, items 2a and 2b.)

G True/False

When used in this way, the item may be used complete, so that all alternatives in an item require a decision by the student as being true or false. Here the teacher may alter one or more alternatives in order to achieve the required balance of true to false statements. Alternatively, the stimulus and/or stem may be simply used with only one of the alternatives. **Knowledge** and some **Comprehension** items seem well suited to this use. (See Appendix II, Item 3.)

H Debates

Some items can provoke lively discussion, and the alternatives can be used as the basis for debates. Items from sections 8, 16 and 17 seem particularly suitable for this. (See Appendix II, Item 4.)

I Research stimulus

For this use, a relatively difficult item, of cognitive level application or above, is taken and thoroughly researched. Explanations are given and evidence cited for the acceptance or rejection of each alternative. (See Appendix II, item 5.)

J Models for constructing other items

This bank provides a range of item types which could be used as models for teachers who wish to construct their own items. If items from the bank are supplemented by teacher-written items, it is suggested that the supplementary items be consistent in style. Some rules for constructing multiple-choice items are outlined on page xv.

2 Preparing Tests

In preparing a test, teachers should:

- identify the particular syllabus areas that are to be evaluated;
- be prepared to use both **correct** and **incorrect** response types of items presented in this Bank (See 1 above), although the two item types should **not** be used together in the multiple-choice section of the test. Note that they are distinguishable in the text by the difference in typeface;
- select items which appear to evaluate the concept areas under consideration;
- write items, where necessary, to provide an adequate coverage of the areas;
- place the items in a logical order. (Group items relevant to similar syllabus areas together. If possible, place the easier items early in the test, with the more difficult items towards the end of the test);
- place items based on the same stimulus material on the one page;
- ensure that one item does not supply the answer to another item;
- check that the items are not ambiguous and that each has an answer listed;
- prepare an answer key;
- ask another teacher to work through the draft, to identify errors and omissions, as well as providing a check on the answer key.

During the trial testing of items, most students completed between six to seven items every ten minutes.

3 Selecting Items

To facilitate item identification, the items have been classified according to their concept areas. These are listed in the Concept Area Table, which incorporates an alphanumeric coding to assist the location of items. The concept area codes, cognitive level, difficulty, answer and item type are given beside each item in the left-hand margin. The following example illustrates this format.

15i-1 15d Co 2 A (c) *

After an area was sprayed with the insecticide DDT, it was found that some populations of mosquitoes were resistant to DDT.

The best explanation for this is that

A mosquitoes naturally resistant to DDT are more likely to survive and reproduce.

B DDT causes individual mosquitoes to become resistant to DDT.

C mosquitoes that become resistant to DDT as a result of the spraying produce offspring resistant to DDT.

D DDT acts on a particular gene causing it to produce an enzyme which destroys DDT.

- The item is most appropriate to concept area 15i. From the table of Concept Areas, 15i represents 'Natural selection changes allele frequencies'.
- This is the first item in this particular concept area.
- This item also tests concept area 15d.
- The approximate cognitive skill being used by most students when answering this item at this year level is **Comprehension**[1]. The items have been classified as follows:

  Kn = Knowledge
  Co = Comprehension
  Ap = Application
  An = Analysis
  Sy = Synthesis
  Ev = Evaluation

- The difficulty of the item, on a scale of 1 (easy) to 5 (difficult) is about 2 (i.e. 60–79 per cent of the trial group of students answered this item correctly—see Introduction) Volume I items were tested at Year 11, Volume II items at Year 12.
- The answer to the item is A.
- This is a **correct** response type item i.e. the student is required to select the one **correct** alternative as the answer. This contrasts with for example, item 14g-5 which is an **incorrect** response type item i.e. the student is required to select the one **incorrect** alternative as the answer.
- The asterisk indicates that either (a) the point biserial correlation for this item was less than 0.1 (i.e. the item did not differentiate well between the more able and less able students as determined by the total score on the trial test), or (b) the item as not included in the trial testing program.

4 Writing Additional Multiple-choice Test Items

Multiple-choice items should incorporate the following points:

- The stem and each alternative must read grammatically when taken together.
- The problem posed or the question asked must be clearly set out in the stem.
- The whole item should be as brief as its proper presentation will allow.
- To keep the alternatives brief, incorporate the major part of the idea in the stem.
- Avoid a negative stem where possible.

  If unavoidable, either
  (a) emphasize **not**, or
  (b) use: all of the following **except** one. Which one?

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[1] for further information, see
Bloom, B.S. (Ed.). *Taxonomy of Educational Objectives*. London. Longmans, Green and Co. 1956.

- **Incorrect** response items should **never** have a negative stem.
- All distractors should be equally attractive to the uninformed, yet the appropriate one must be unequivocally the best alternative.
- Avoid using 'none of the above' as a distractor.
  A preferred alternative is,
  for example: **D** neither **A**, nor **B**, nor **C**.
- All alternatives must be homogeneous in idea and style.
  For example: Do not mix functions and structures.
- Words such as 'all', 'never', 'always', 'only', should not be used indiscriminately.
- Information presented in the stem must be factually correct.
- Distractors must be clearly **correct** or (depending on item type) **incorrect**, and not merely incomplete.

For a more comprehensive treatment of test construction and item writing, see: Izard, J.F., *Construction and Analysis of Classroom Tests*, ACER 1977.

5 Adding Other Types of Items

This item bank may be used as the starting point for a collection of a variety of test item types. True—False, extended response and essay items may be written or collected from examination papers and included in the relevant concept areas after appropriate keying.

6 Symbols, units and terminology

In order to maintain some degree of internal consistency within this publication it has been necessary to select between the expressions in current use. It is anticipated that teachers will adapt items to their local needs where necessary. The SI units of measurement have been used, including the use of mL for millilitre.

Concept Areas: Volumes I and II

Volume I: The Living World

1 Investigating the Living World

a Organisms interact with their surroundings
b Autotrophs and heterotrophs
c Respiration

2 The Variety of Life

Kinds of Organisms

a Speciation
b Identifying and describing species
c Classifying species

Classification

d Animals
e Plants
f Microorganisms

3 Organisms and Environments

Living Things and Living Places

a Factors affecting a species' survival
b Habitats: similarities and differences; living in water

Adaptation

c Survival on land: inherited features
d Survival by response to the environment

4 Reproduction

Reproductive Processes

a Sexual and asexual reproduction
b Sexual reproduction and variability
c Reproductive systems

Reproduction and Survival

d Characteristics enabling reproduction, survival and dispersal
e Life cycles and their reproductive stages

5 Nutrition, Development and Growth

Development and Growth

a Development in a lifetime
b Growth; cell growth, differentiation, death and replacement
c Patterns of development relating to habitat and structure

Nutrition

d Food materials
e Variations in nutritional requirements

6 Populations

Numbers of Organisms

a Factors affecting distribution of a species
b Factors affecting populations and densities
c Rates of population change

Survival

d Living in groups
e Adaptation, variation and selection
f Factors affecting population survival

7 Interaction and Change in the Natural World

Organisms in the Community

a Community structure
b Community interrelationships
c Infectious disease

The Changing Community

d Types of change
e Effects of change

8 The Living World

The Natural World

a Interdependence of community and environment
b The dynamic ecosystem
c The biosphere

Effects of Human Activity

d Typically human ecosystems
e Human activity and the biosphere
f Understanding and managing the biosphere

Volume II: The Functioning Organism

9 The Organism

The Individual Organism

a Structure, environment and habitat
b Maintenance and response
c Organs, systems and functions

Cells

d Basic cell structure and products; prokaryotes and eukaryotes
e Cell similarities and differences within multicellular organisms
f Cell origin and structure—function relationships
g Mitosis; growth, replacement, reproduction

10 Function and Structure in Plants

a The variety of plant structure

Input and Output

b Vascular plant structure facilitates photosynthesis
c Gaseous exchange and water loss in terrestrial plants

Plant Structure—Function Relationships

d Transport, storage and waste disposal

Plants and the Environment

e Structural adaptations
f Germination, growth and reproduction in angiosperms
g Adaptation, efficiency and inheritance

11 Function and Structure in Animals

Input and Output

a Structure and function in organs and systems
b Digestion, absorption, assimilation, storage and elimination
c Respiratory systems and surfaces, gaseous exchange
d Mammalian excretion maintains a constant internal environment

Mammalian Internal Transport and Maintenance

e Exchange and transport by blood vascular and lymphatic systems
f Maintenance of the cellular environment
g Tissue maintenance and the immune system

Animals and the Environment

h Sense organs, body surfaces and musculo-skeletal systems
i Structural diversity, adaptation, efficiency and inheritance

12 Integration and Regulation in Multicellular Organisms

Integration and Control

a Integration and regulation of body functions; response to change
b Nervous systems and hormones control the multicellular organism
c Internal regulation by homeostasis

Chemical Regulation in Plants

d Angiosperm response throughout development; chemical control

Behaviour Patterns

e Normal functioning and reproduction aided by behaviour
f Determiners of behaviour: heredity, experience, environment, physiology

Regulation and Control in Multicellular Animals

g Nervous systems
h Endocrine systems

13 Cellular Processes

Activities within Cells

a Cell chemical composition and basic requirements
b Cell respiration
c Enzymes
d Photosynthesis as a chemical process

Cell Ultrastructure and Function

e Cell organelles and chemical processes
f Membranes as dynamic structures

Molecular Interactions

g Chemical reactions in cells, and their control
h Molecular structure; its effect on chemical and physical processes

14 Heredity

Inheritance as a Phenomenon

a Inheritance and environment determine characteristics
b Chromosomes; transfer during life processes, homologous pairs
c Meiosis and fertilization maintain chromosome sets
d Sexual reproduction aids variability within the species
e Chromosomes and genes determine inheritance

Patterns of Inheritance

f Alleles and their origin; types of dominance
g Gamete and genotype frequencies; monohybrid crosses, multiple alleles
h Independent assortment of two or more genes on different chromosomes
i Linkage, crossing-over, chromosome mapping

DNA, Genes and Chromosomes

j Chromosomes and genes consist of DNA; DNA may be extranuclear

Gene Action

k How gene structure determines protein synthesis
l Phenotype as gene expression
m Gene activity controls cellular activities

15 Life—Its Continuity and Change

Life from the Past

a Fossils and their formation; geological time scale
b Evidence of change in the fossil record

Natural Selection and Change

c Speciation, variation, selection and evolution
d Survival and changes in populations
e Environmental effects on population characteristics
f Mutations provide the raw material for evolutionary change
g The development of new species

Mechanisms of Evolution

h Convergence, sex differences and mimicry
i Natural selection changes allele frequencies
j Formation of subspecies and new species by adaptation and isolation
k Population distributions related to changes in land forms

16 The Human Species

Homo sapiens

a Human characteristics and their variation
b Human origins and fossil evidence

Science and Society

c Human cultures result from learning and communication
d Scientific approaches to problem solving; technology
e The effects of science and technology on culture and the biosphere
f The effects of applying scientific knowledge to human problems

17 Science and the Scientific Process

a Science as a part of human culture

How a Scientist Works

b Apparent relationships may be found between observations
c Questions are posed, observations made, data collated and compared
d Hypothesis, predictions, experimental design to test hypothesis
e Experimental results and hypothesis evaluation
f The scientist is thorough, logical and objective

The Scientist in the Scientific Community

g Development and use of appropriate tools and techniques
h Internationally accepted names, symbols and units
i Reports assist with accurate communication
j Publication: a record for dissemination, inviting scrutiny and duplication
k Scientific ideas: acceptance, predictability, re-examination

The Scientist in Society

l Awareness of the consequences of investigations
m Some issues are beyond the limits of science
n Science and its effects on culture and the biosphere

9 THE ORGANISM

The Individual Organism

9a—Structure, environment and habitat

CORRECT response items

9a-1 – Co 1 (c) C

The Numbat, *Myrmecobius fasciatus*, is a small ground-dwelling marsupial with a striped body and a large brush-like tail. It feeds almost exclusively on termites which are plentiful in the soil and dead wood of the eucalypt forest and woodland where it lives. It exposes termites with its forepaws, picks them up with its long, worm-like tongue, and usually swallows them without chewing.

Which structural characteristic of the Numbat appears **least** related to the activities described?

A salivary glands secreting sticky mucus
B strong forelimbs with long claws
C long brush-like tail
D long snout and tongue

9a-2 – Co 3 (c) A

Sundews are herbs which often grow in swamps. Their stems and leaves are covered with sticky hairs ending in glands which secrete digestive enzymes. Small insects are trapped by the hairs, digested, and the products of digestion absorbed by the plant.

Which feature of the sundew's habitat is **most** closely related to the insectivorous nature of the plant?

A Swampy soils are too wet for the survival of nitrogen fixing bacteria.
B Swamps support insects capable of pollinating sundew flowers.
C Trees seldom grow in swamps so shade is lacking.
D Insectivorous birds are uncommon in swamps allowing plants to feed on the abundant insects.

9a-3 – Ap 3 (c) B

Rhizanthella gardneri is a Western Australian orchid species which lives underground. Microscopic studies show that some of its cells contain masses of fungal threads which are periodically digested.

A structural feature of this plant **most** closely associated with its way of life would be its

A thickened resistant seed coats.
B absence of leaves.
C fleshy non-splitting fruits.
D short thick underground stems.

INCORRECT response items

9a-4 – Ap 2 (I) A

Flamingoes are wading birds that feed on microscopic aquatic organisms. They are filter feeders. The beak and tongue combine to push water through a system of hair-like lamellae at the edges of the beak, thus straining off the food. A flamingo normally consumes 10 per cent of its bodyweight in food each day.

Consider a flamingo found in a lake with a relatively low concentration of microorganisms.

This bird would be expected to

A find an alternative food type.
B feed for longer periods of time.
C move to another habitat.
D start to lose bodyweight if it remained.

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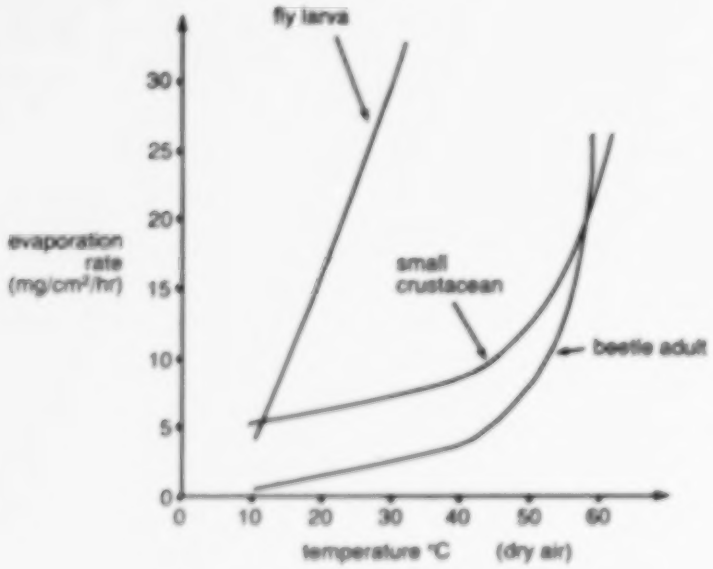
9a-5 – Ap 2 (i) A Characteristics enhancing the survival of Antarctic seals in their habitat could include

A extremities warmed by a rich supply of blood vessels.
B a fat layer under the skin acting as an insulator.
C a streamlined body shape facilitating rapid movement through the water.
D eye structure enabling vision both underwater and in air.

9a-6 – An 4 (i) B • The graph shows the relationship between the temperature of the environment and the evaporation of water from three different organisms.



It is reasonable to suppose that

A the waxy cuticle of the beetle would help reduce the evaporation of water from its body.
B between 10 °C and 40 °C the small crustacean loses more water than the beetle.
C the three organisms would lose less water by evaporation if the humidity were increased.
D the fly larva is less well adapted to variations in temperature than either the small crustacean or the beetle.

9b—Maintenance and response

CORRECT response items

9b-1 – Co 1 (c) A • Four organisms have the sets of requirements as set out in the table:

Organism	Organic compounds	CO_2	O_2	H_2O	Mineral ions	Light energy
I	✓		✓	✓	✓	
II	✓	✓			✓	✓
III	✓	✓		✓		
IV		✓	✓	✓	✓	✓

Which set indicates the most complete list of the requirements of a heterotroph?

A I
B II
C III
D IV

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9b-2, 11i Kn 3 (c) A — The principal function of the contractile vacuole in a protozoan is

A removal of water.
B excretion of wastes.
C support by turgor.
D digestion.

9b-3 - An 2 (c) A — Marine iguanas live on rocky sea shores of the Galapagos Islands. They feed on seaweed growing on the sea floor, but spend most of their time crouching on nearby rocks. Early each morning these reptiles may be seen with their bodies pressed against the rocks. By noon they extend their legs fully and remain for several hours with their bodies well above the rock surfaces. Late in the afternoon they return to their morning position.

The position adopted at noon is a response to the

A increased body temperature as heat is absorbed from the warm rocks.
B regulation of salt content acquired by feeding in the sea.
C increased oxygen levels in the blood as the area of skin freely exposed to the air increase.
D decreased body temperature from exposure to cool sea water during feeding.

INCORRECT response items

9b-4 - Co 2 (i) A — Organisms display abilities to cope with changing environmental conditions.

These abilities would include

A altering tolerance limits.
B feeding on a variety of foods.
C changing the composition of waste products.
D modifying behaviour.

9b-5 - Co 2 (i) D — The Euro is a land animal found in very arid parts of Australia. Its survival depends on its ability to conserve moisture.

Each of the following adaptations could be expected to reduce water loss.

A feeding and moving around mainly at night
B a reduced number of sweat glands in the skin
C reduced metabolic and breathing rates
D decreasing the concentration of urine excreted

9b-6 - Ap 2 (i) D * — The body temperature of the camel has a greater daily range than that of other animals; it may be 34 °C in the morning and over 40 °C in the afternoon.

Each of the following is a valid explanation of the camel's ability to survive in the desert.

A The temperature difference between the camel and its environment is reduced.
B The camel accumulates heat which is later lost during the cool of the night.
C The camel sweats very little until its temperature reaches about 40 °C and so it loses less water.
D The camel's metabolic rate increases as its body temperature rises.

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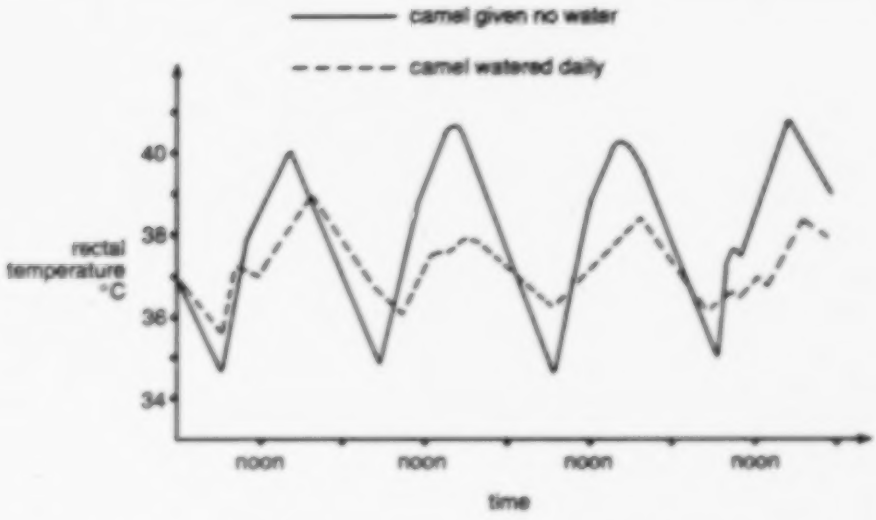
9b-7 – An 3 (i) C

The rectal temperatures of two camels (one watered daily and the other given no water) were measured over four days. The air temperature and behaviour was the same for both camels.



Using your knowledge and the data given it would be reasonable to conclude that

A under conditions of water shortage in a camel, the loss of heat by evaporation of water is reduced.
B most heat loss occurs by conduction and radiation at night.
C the difference in rectal temperatures between the two camels is greater at night than during the day.
D both camels display homoiothermic mechanisms.

9c—Organs, systems and functions

CORRECT response items

9c-1 – Kn 2 (c) D

In single-celled organisms the cell membrane is responsible for the exchange of gases, the input of nutrients and the removal of wastes.

In man these three functions are carried out by the

A nose, large intestine and kidney.
B bladder, rectum and lungs.
C blood, stomach and skin.
D kidney, small intestine and lungs.

9c-2 – Co 2 (c) D

Which of the following lists has the terms arranged in order of increasing complexity of structure?

A organelle, cell, organ, system, tissue
B cell, organ, organelle, tissue, system
C organ, organelle, tissue, system, cell
D organelle, cell, tissue, organ, system

INCORRECT response items

9c-3 – Kn 4 (i) A

Each of the following groups of organs is found in a particular mammalian system.

A kidneys, bladder, anus
B eyes, skin, ears
C heart, veins, arteries
D ovaries, vagina, uterus

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9c-4 9a Ap 2 (i) D

Many animals have external receptors that can detect changes in the surroundings of the animal. A rattlesnake has a depression on each side of its head containing thousands of receptors to detect the presence of its prey.

The following support the fact that these are heat receptors, rather than light or chemical receptors.

A If a rattlesnake is placed in complete darkness it can still strike accurately at a mouse.

B If a mouse is sprayed with a smelly fluid to obscure its natural odour, a blindfolded rattlesnake will still strike and hit the prey.

C If the two pits are covered with sticking plaster, the snake loses its ability to catch mice in the dark.

D If a dead mouse killed the day before is placed near a blindfolded rattlesnake, the snake will still strike accurately.

Cells

9d—Cell structure and products; prokaryotes and eukaryotes

CORRECT response items

9d-1 – Kn 2 (c) B

Some bacteria are structurally similar to each other. Because of this many biologists consider that they should be classified into one group, the Prokaryotes.

The basis of this classification is that Prokaryotes

A cannot photosynthesize.

B lack a distinct nucleus.

C occur only in oxygen depleted habitats.

D show no tendency toward a multicellular structure.

9d-2 – Kn 4 (c) D

Which one of the following features of prokaryotic cells does **not** distinguish them from eukaryotic cells?

Prokaryotic cells

A are extremely small (less than 5 microns).

B have no membrane-bound nuclei.

C show relatively little internal organization.

D have a cell wall.

9d-3 17b Kn 4 (c) C

Tropical fruits such as bananas and avocados suffer discolouration if they are stored at too low a temperature. This effect is known as 'chilling injury'. An hypothesis was put forward that chilling injury was a result of damage to membranes.

The following observations were made of cells suffering from chilling injury. Which one does **not** support the hypothesis?

A The rate of oxygen uptake in the mitochondria decreased.

B Water and salts were lost from the cell.

C Some cytoplasmic enzymes became inactivated.

D Structural changes occurred in certain phospho-lipids.

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9d-4
17b
Co
3
(c)
B

By the end of the eighteenth century, scientists were beginning to realize that cells were important parts of all living organisms. The French scientist, Jean Lamarck wrote in 1809: 'Every living body is essentially a mass of cells'.

At that time, Lamarck's scientific thinking would have represented

A a theory.
B an hypothesis.
C an observation.
D a law.

9d-5
–
Co
4
(c)
A
*

If the first cells evolved in an environment containing only water, ammonia, hydrogen and organic compounds, we may suppose that their metabolism resembled that of

A anaerobic heterotrophs.
B aerobic heterotrophs.
C anaerobic autotrophs.
D aerobic autotrophs.

INCORRECT response items

9d-6
–
Kn
2
(l)
C

Prokaryotic organisms differ from eukaryotic organisms in that they

A are smaller.
B do not possess a distinct nucleus.
C are unable to photosynthesize.
D lack distinct organelles.

9d-7
–
Kn
2
(l)
A

Prokaryotes have the following characteristics.

They

A have no membranes.
B contain some genetic material.
C may be autotrophic.
D are usually unicellular.

9d-8
17g
Kn
4
(l)
A

The following structures are visible when meristematic tissue is viewed under a light microscope.

A ribosomes
B granules
C vacuoles
D chromosomes

9e—Cell similarities and differences within multicellular organisms

CORRECT response items

9e-1
–
Kn
1
(c)
A

The sites of energy release are the

A mitochondria.
B nucleoli.
C chloroplasts.
D ribosomes.

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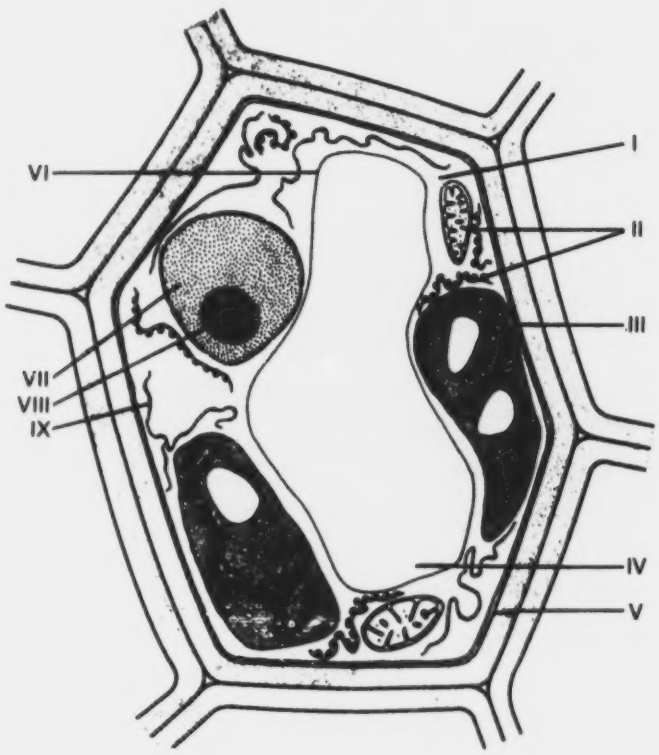
The next 5 items refer to the following information:



9e-2 **17g** **Kn** **1** **(c)** **D**

Which one of the following is a major component of the part of the cell labelled IV in the diagram?

A DNA
B protein
C lipid
D water

9e-3 **17g** **Kn** **3** **(c)** **C**

Which one of the following is the major component of the structure labelled V in the diagram?

A lipid
B DNA
C carbohydrate
D water

9e-4 **17g** **Kn** **2** **(c)** **D**

The endoplasmic reticulum is labelled

A I.
B III.
C VI.
D IX.

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9e-5 17g Kn 3 (c) C *

In which one of the following do lipids have an important structural role?

A II
B V
C VI
D VII

9e-6 17g Kn 3 (c) B

Starch granules would most likely be located in

A I.
B III.
C IV.
D VII.

9e-7 – Ap 3 (c) A

Bacteria were once classified as plants.

An observation supporting this classification is that bacteria

A possess a cell wall.
B do not contain mitochondria.
C do not undergo mitosis.
D are autotrophic.

INCORRECT response items

9e-8 17g Kn 2 (l) A

A student examined four cell types from different organisms under a microscope. He placed a mark in the table below when he was certain that a structure was present; otherwise he left the space blank.

cells	I	II	III	IV
nucleus	✓		✓	✓
nucleolus			✓	✓
cell wall		✓		
cell membrane	✓		✓	✓
cytoplasm	✓		✓	✓
vacuole				✓
green plastid (chloroplast)		✓		
white plastid (leucoplast)				✓
cytoplasmic movement	✓	✓		

From these observations it is true to say that

A cell I must be from an animal.
B cell II must be from a plant.
C cell III could be from an animal or a plant.
D cell IV could be from a plant.

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9e-9 The following features are characteristic of living animal cells.

– Kn 1 (I) D

A centrioles
B nucleoli
C mitochondria
D leucoplasts

9e-10 Each of the following structural features is common to the cells of both ferns and frogs.

– Kn 1 (I) C

A vacuoles
B nuclei
C cell walls
D mitochondria

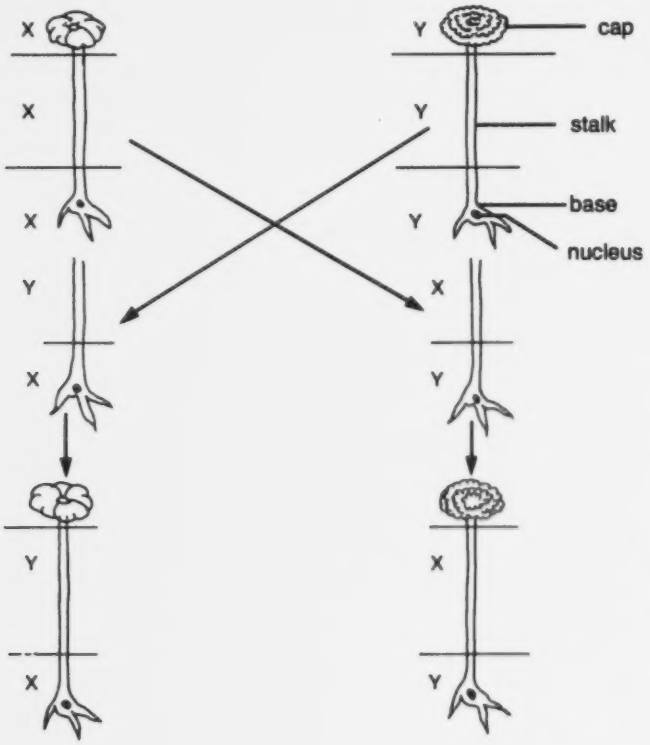
9f—Cell origin, and structure–function relationships

CORRECT response items

9f-1 17b An 3 (c) A

A scientist carried out an experiment using two species of single-celled algae (species X and species Y). Each alga was cut into three pieces, the caps discarded, the stalks grafted onto the opposite base and left until new caps grew.

The diagrams indicate how the experiment was carried out, and the eventual results.



The hypothesis the scientist was testing was **least** likely to be that

A regeneration of the cap is possible in these algae.
B the type of cap which grows is controlled by the stalk.
C the growth of the cap is controlled by the nucleus.
D the growth of the cap is independent of the base.

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INCORRECT response items

9f-2
9g
Kn
2
(I)
B

The following statements apply to mitosis.

A Two daughter nuclei are produced which have an identical set of chromosomes to that of the parent cell.
B The two daughter cells produced are similar in size to the original parent cell.
C The number of chromosomes is usually the same in any one species.
D Mitosis is an essential process for tissue repair.

9f-3
–
Kn
2
(I)
C
*

The following statements are consistent with the cell theory.

A The cell is the unit of structure and function.
B Some structures are not cellular in form.
C All organisms consist of many cell types.
D All cells derive from pre-existing cells.

9f-4
9e
Co
4
(I)
A

Vacuoles may function to

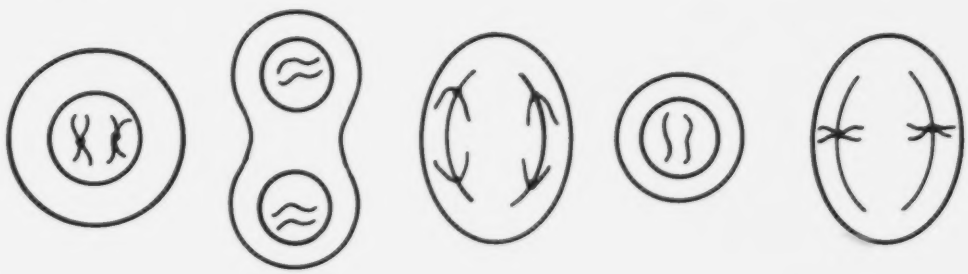
A store nitrogenous waste.
B enclose and digest food.
C store water and dissolve mineral ions.
D expel water.

9g—Mitosis; growth, replacement, reproduction

CORRECT response items

9g-1
–
Kn
2
(c)
C

The diagram illustrates some of the main events in mitosis.



I II III IV V

The correct sequence of these events is as follows:

A IV, II, III, V, I.
B IV, III, V, I, II.
C I, V, III, II, IV.
D II, I, V, III, IV.

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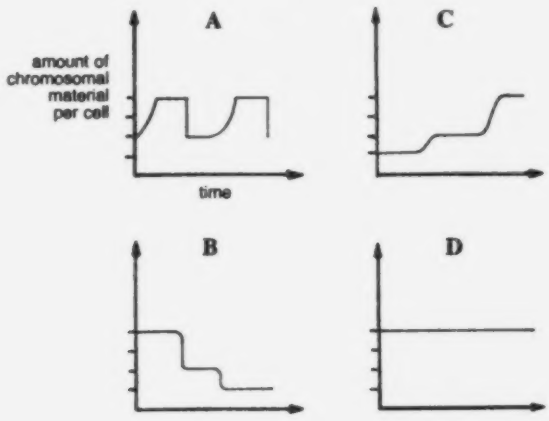
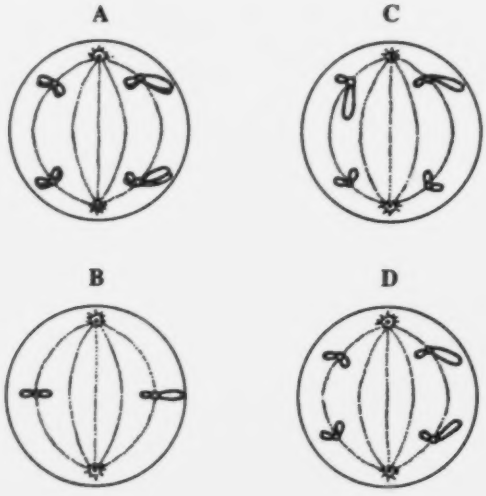
9g-2 Which one of the graphs below is the best representation of two complete cell divisions by mitosis?

–
Co
2
(c)
A



9g-3 Which one of the diagrams represents a stage in mitosis?

–
Co
3
(c)
D



INCORRECT response items

9g-4 During the process of mitosis

–
Kn
2
(l)
A

A the DNA content of each cell remains unaltered.
B the chromosomes are duplicated.
C the centromeres divide.
D the new nuclei form at the poles of the spindle.

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9g-5 – Kn 2 (i) A Mitosis is the process responsible for the

A production of digestive enzymes.
B growth of an embryo.
C production of red blood cells.
D replacement of worn tissue lining.

9g-6 – Kn 2 (i) C The reproductive cycle of a cell during mitosis consists of a doubling of all the components of the cell, followed by a division that distributes the components to the daughter cells.

This process includes

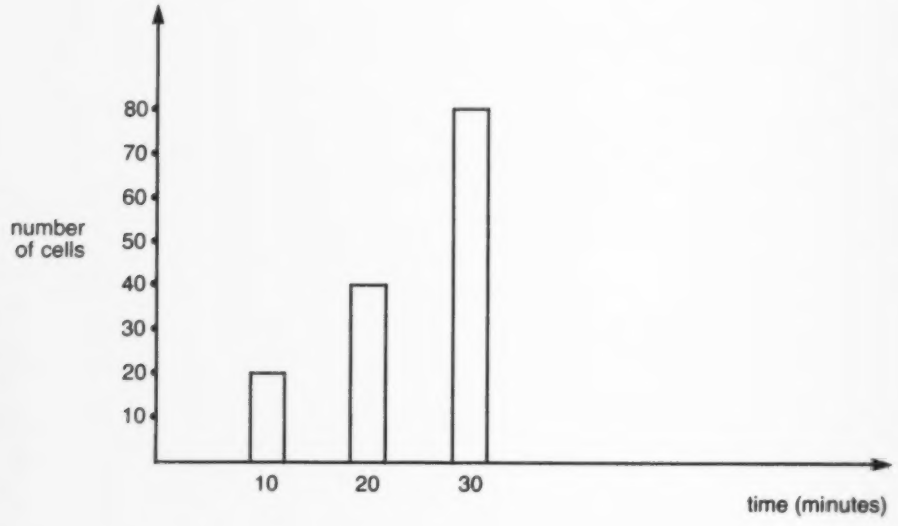
A the doubling of the DNA in the nucleus during interphase.
B the appearance of each chromosome as two chromatids during prophase.
C shortening and thickening of chromosomes during metaphase.
D the separation of the individual chromatids to the poles during anaphase.

9g-7 17g Kn 3 (i) C When comparing the fine structure of dividing cells in animal and plant tissue one could state that in dividing plant cells

A there are no centrioles.
B there are no asters.
C there is no spindle formation.
D there is no furrowing of the cytoplasm.

9g-8 – Co 1 (i) B A biologist isolated some somatic plant cells and placed them in a suitable nutrient medium. The number of cells present in the medium was determined at regular intervals over the next few hours.

Some of the data have been graphed below.



It would be reasonable to assume that

A approximately ten cells had been isolated initially.
B approximately 640 cells would be present after 50 minutes.
C the particular cell type took 10 minutes to divide mitotically.
D the cells would not continue to divide indefinitely in the medium.

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9g-9 – Co 4 (i) C

If a particular mammalian cell type is found to divide mitotically every 20 minutes it would be reasonable to assume that

A after an hour the total number of cells would have increased approximately eight times.
B each new cell would be diploid.
C each new cell would contain one chromosome from each homologous pair.
D the amount of DNA in each parent cell would have doubled at some stage prior to the completion of each successive 20 minute interval.

9g-10 – Ap 4 (i) B

The table shows some results recorded with liver cells undergoing mitosis.

Stage in mitosis	Prophase	Metaphase	Anaphase	Telophase	Interphase
Time taken (mins)	6	7	4	9	14

It would be reasonable to assume from the data that

A the spindle would be visible for no more than 26 minutes.
B separation of the chromatids would take approximately 7 minutes.
C one mitotic cycle would be completed every 40 minutes.
D the cytoplasm would start dividing 17 minutes after chromosomes become visible.

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10 FUNCTION AND STRUCTURE IN PLANTS

10a—The variety of plant structure

CORRECT response items

10a-1 A brown-coloured plant is classified by a biologist as an autotroph.

–
Co
5
(c)
D

Which one of the following statements is true of this organism?

A The plant must have been growing on another living organism, e.g. a tree.

B The plant must have been using organic matter from the substrate or material it was growing on.

C There is some doubt that the plant is an autotroph because brown autotrophs are as yet unknown.

D The plant must have been growing on a substrate or material lacking organic matter.

10a-2 The diagram shows some different cell shapes, all having the same volume.

–
Co
2
(c)
A
*

I II III IV

Which of the following lists the shapes in order of **increasing** surface area to volume ratio?

A IV, II, III, I

B III, I, II, IV

C I, II, III, IV

D IV, I, II, III

INCORRECT response items

10a-3 Ferns and algae are different in that

–
Kn
3
(I)
A

A the stomata of algae are located only on the upper surfaces.

B algae have less internal support tissue.

C ferns have a more advanced transport system.

D ferns require a root system to obtain nutrients.

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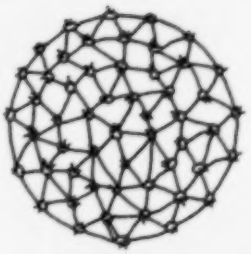
10a-4 Compare the structures of the two freshwater algae shown.

–
Co
2
(i)
D

Euglena (100 μm long)



Volvox (400 μm diam.)

It is reasonable to predict that

A both *Euglena* and *Volvox* are capable of locomotion.
B individual cells of a *Volvox* colony are more specialized than *Euglena*.
C neither *Volvox* nor *Euglena* requires an internal transport system.
D the cells comprising a *Volvox* colony act independently of each other.

10a-5 When comparing an *Amoeba* with a cell of the same size from a multicellular organism,

10d
Co
2
(i)
A
*

A the *Amoeba* is able to absorb less nutrients from its surroundings.
B both cell types allow for the exchange of gases and waste materials through a cell membrane.
C the total surface area of an *Amoeba* is less than the total surface area of all the cells of the multicellular organism.
D the individual cells of both organisms can exchange materials with the external environment.

Input and Output

10b—Vascular plant structure facilitates photosynthesis

CORRECT response items

10b-1 In a greenhouse, young corn plants are grown under optimal conditions of soil, temperature, and humidity.

–
Ap
2
(c)
A
*

Which one of the following procedures would probably increase the rate of photosynthesis?

A increasing the carbon dioxide content of the atmosphere by a small amount
B increasing the amount of green light available
C increasing the oxygen content of the atmosphere by a large amount
D adding very small amounts of sucrose and mineral ions to the soil

10b-2 Flattened, relatively thin leaf blades enable some plants to achieve a large surface area to volume ratio.

–
2
Ap
(c)
B

This would **not** increase the

A release of water during transpiration.
B absorption of nitrogen for protein synthesis.
C uptake of carbon dioxide for photosynthesis.
D absorption of light for photosynthesis.

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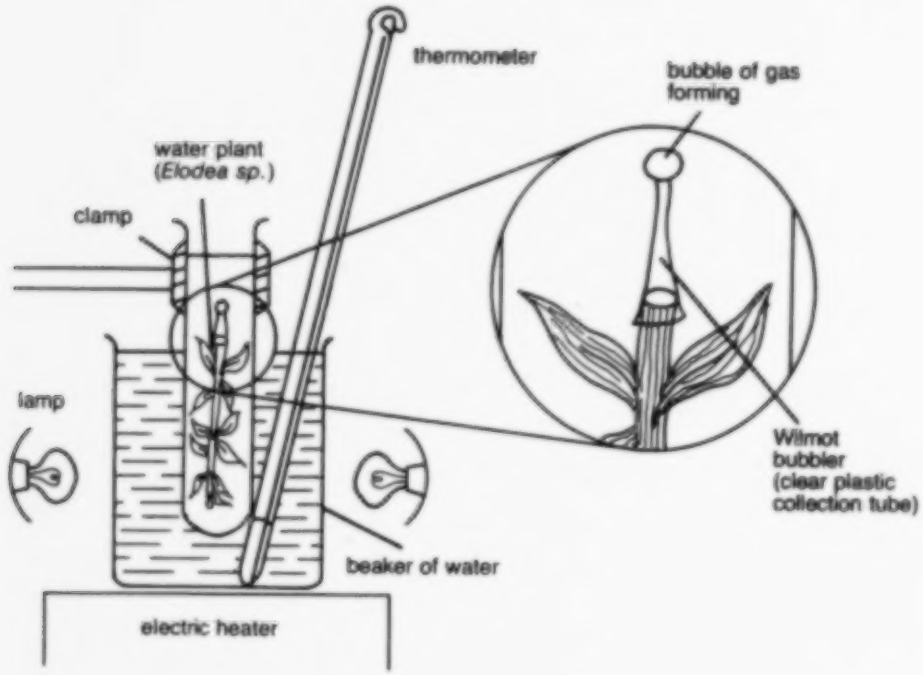
10b-3 – Co 2 (c) C

An experiment was conducted using the equipment illustrated in the diagram below. The lamps were turned on for the duration of the experiment. The bubble of gas from the plant was collected and analysed.



A class did the experiment, and wanted to improve the rate of production of gas by the plant. Each of four groups added one compound to the water, as set out below.

Group	Added	Effect on water
I	Hydrochloric acid	Increased acidity
II	Sodium hydroxide solution	Increased alkalinity
III	Sodium hydrogen carbonate solution	Increased concentration of carbon dioxide
IV	Hydrogen peroxide	Increased concentration of oxygen

Which group increased gas production the most?

A I
B II
C III
D IV

10b-4 – Ap 2 (c) D

Epidermal cells on aerial parts of land plants often secrete a waxy, water-resistant cuticle on their outer surface.

Of the following statements, which is **not** an explanation of the value of the cuticle to the plant's normal functioning?

A protection for the plant against water loss
B a barrier to invasion by disease-causing microorganisms
C protection against tissue damage
D aiding diffusion of oxygen for cell respiration

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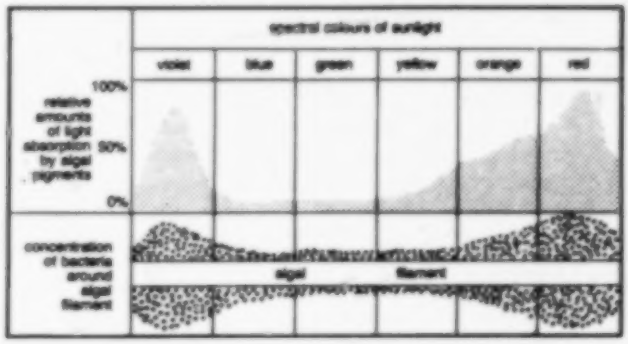
10b-5 17d An 1 (c) D The diagram below summarizes the results of a very early experiment to determine whether the rate at which a green alga carried out photosynthesis varied with light of different colours.

The biologist who performed the experiment considered that, where the rate of photosynthesis was greatest, there would be an increase in the concentration of oxygen.

To measure the relative differences in oxygen concentration, he made use of the fact that certain bacteria congregate in regions where the concentration of oxygen is high.



Which of the following statements is best supported by these results?

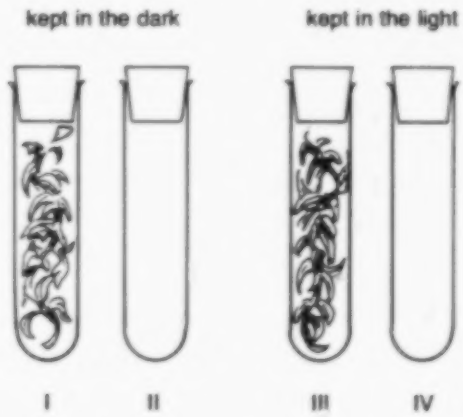
A The green alga absorbed the greatest relative amount of light when exposed to green light only.

B The bacteria exposed to violet light had a greater oxygen requirement than those exposed to yellow light.

C The bacteria used in the experiment cannot survive in the absence of oxygen.

D The green alga had the greatest rate of photosynthesis when exposed to violet and red lights.

10b-6 17d An 3 (c) B Four test-tubes were set up as shown in the diagram. Sterile water was used to fill all the tubes. (Sterile water contains no living organisms.) Tubes I and III also contained pieces of water plant.



The four tubes were kept at the same temperature. The oxygen content of each tube was measured at the end of two hours.

Which one of the following gives the tubes in the expected order of increasing oxygen concentration from lowest to highest?

A II and IV equal, I, III

B I, II and IV equal, III

C II, I, IV, III

D I, III, II and IV equal

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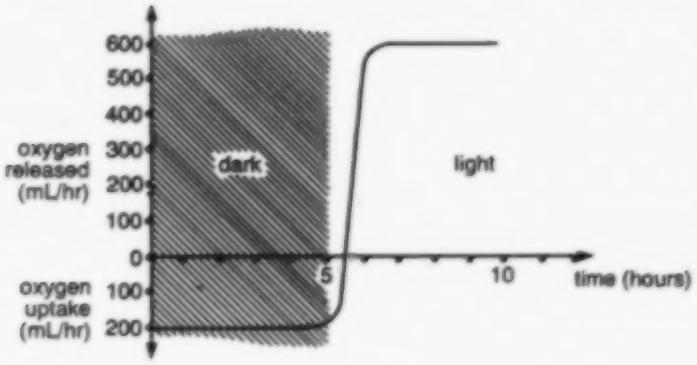
The next 2 items refer to the following information:

During an experiment on gaseous exchange in plants, data were obtained relating to the rate of oxygen uptake and release by a shoot of water weed. The shoot was in darkness for five hours and then placed in daylight for five hours. The temperature remained constant. The results were plotted on a graph as follows:



10b-7 – An 4 (c) C

If it is assumed that changes in light intensity have no effect on the rate of respiration, what would be the best estimate of the total volume of oxygen used by the shoot for respiration, during the ten hours of the experiment?

A 200 mL
B 1000 mL
C 2000 mL
D 2400 mL

10b-8 – An 5 (c) D

If we assume that changes in light intensity have no effect on the rate of respiration, what would be the best estimate of the total amount of oxygen produced by photosynthesis during the **last** two hours of the experiment?

A 600 mL
B 800 mL
C 1200 mL
D 1600 mL

10b-9 17b Co 2 (c) C

When the shoot of a bean seedling is cut off above soil level, sap continues to flow from the surface of the stump for some time by a process termed root pressure. If a plant whose shoot is cut off is then deprived of oxygen, root pressure apparently ceases.

An hypothesis supporting these observations is that the root pressure ceases because

A the absence of leaves reduces photosynthesis.
B the absence of leaves reduces transpiration.
C the absence of oxygen prevents respiration.
D the absence of oxygen prevents photosynthesis.

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INCORRECT response items

10b-10 A typical autotrophic organism has structural features which can be related to its way of life.

\- Kn 1 (I) B

These features are involved with

A the absorption of light energy and its conversion to chemical energy.
B the taking in of energy-rich compounds from the soil.
C the taking in of carbon dioxide from the air.
D the absorption of water and mineral nutrients from the soil.

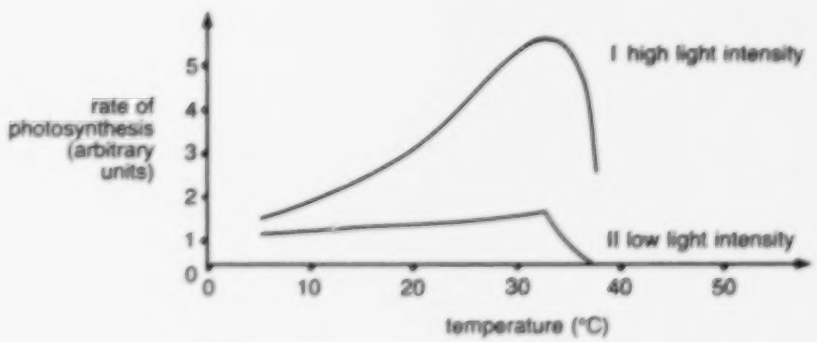
10b-11 All living cells of a green leaf require

\- Kn 1 (I) C

A carbohydrates.
B oxygen.
C carbon dioxide.
D water.

10b-12 Experiments were conducted to measure the rate of photosynthesis under different conditions. The results are shown as follows:

\- Co 1 (I) B



The following conclusions may be drawn from these data.

A The rate of photosynthesis is dependent on temperature.
B The rate of photosynthesis is dependent on carbon dioxide concentration.
C The rate of photosynthesis is dependent on light intensity.
D A graph for medium light intensity would lie between line I and line II.

10b-13 The external surfaces of glass greenhouses are usually whitewashed at the start of summer. This pure white coating is gradually weathered away by the following winter.

\- Ap 2 (I) C

This white washing and subsequent weathering would aid plant growth by

A reducing penetration of sunlight in summer and therefore keeping temperatures down.
B diffusing light and therefore helping to reduce areas shaded by the greenhouse frame.
C removing the green component from sunlight and therefore maximizing the penetration of blue and red light.
D gradually allowing greater penetration of sunlight as the sun's intensity decreases towards winter.

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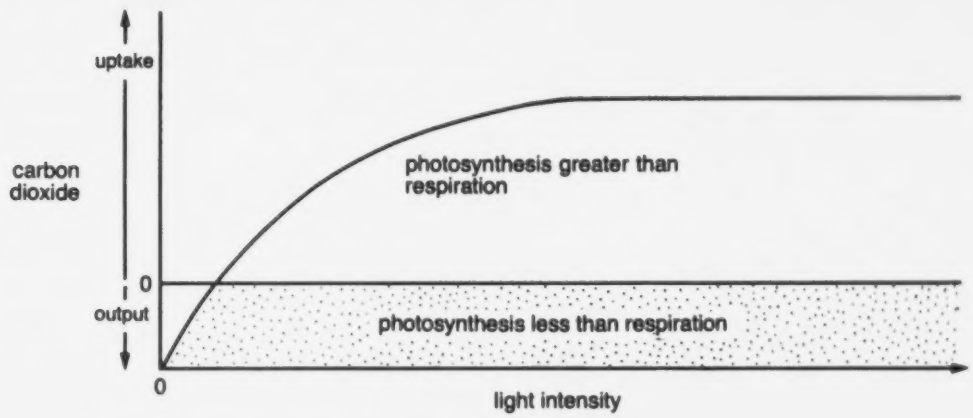
10b-14 – Co 3 (I) D The relationship between carbon dioxide movement and light intensity in a leaf is illustrated in the following graph.



Each of the following is supported by this information.

A Photosynthesis does not occur without light.
B Carbon dioxide output is proportional to light intensity.
C As light intensity increases, the rate of photosynthesis becomes greater than the rate of respiration.
D Respiration rate increases with light intensity.

10b-15 – Ap 3 (I) A Imagine you are able to detect various changes in gaseous content in an intercellular space within a green leaf.

You would notice that

A between 7 a.m. and 12 noon the concentration of water vapour would increase.
B during the night, the carbon dioxide concentration would rise.
C between 7 a.m. and 12 noon the carbon dioxide concentration would decrease.
D oxygen would be leaving the surrounding cells during the daylight hours.

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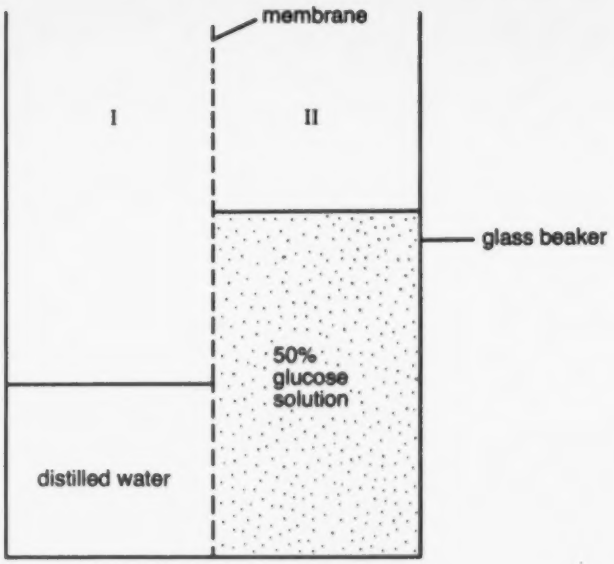
10b-16 The following diagram shows a system designed to demonstrate diffusion and osmosis.
17c
Ap
4
(I)
C



The membrane is permeable to both water and glucose molecules although glucose molecules (molecular weight 180) are much larger than water molecules (molecular weight 18).

The system is set up so that no leakage can occur around the sides of the membrane dividing the two compartments I and II. The initial volume of liquid in I is half that in II. The apparatus is left to stand until diffusion is complete.

Observations made during the experiment would include

A a rise in the level of fluid in compartment II.
B the presence of glucose in compartment I.
C a 50 per cent glucose solution in both compartments I and II.
D equal fluid levels in both compartments.

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10c—Gaseous exchange and water loss in terrestrial plants

CORRECT response items

10c-1 – Co 2 (c) C

A live bean plant was placed in a beaker of distilled water to which potassium ions had been added so that potassium ion concentration in the water was the same as that in the roots of the bean plant. After the plant had been in the solution for one day, its roots were found to have a potassium ion concentration of 32 parts per million, while the solution in the beaker had a concentration of only 20 parts per million.

The flow of potassium into the roots can be explained on the basis of

A diffusion.
B osmosis.
C active transport.
D transpiration.

10c-2 10g Co 2 (c) D

The amount of water vapour lost to the atmosphere by a plant is **reduced** if there is an increase in

A the intensity of sunlight.
B availability of soil water.
C wind velocity.
D relative humidity of the air.

10c-3 – Ap 2 (c) C

It is common practice for gardeners to remove many of the leaves of a plant before they transplant it.

This is thought to improve the plant's chance of survival since this treatment

A stimulates the plant to produce new growth rapidly.
B ensures that the rate of photosynthesis in the remaining leaves is at a maximum.
C reduces transpiration loss and so counters the effects of possible root damage through transplanting.
D ensures the rapid adaptation of the plant to its new environment.

10c-4 – Ap 4 (c) D *

Some leaves of a broad bean seedling were coated with a water-proofing agent, petroleum jelly. Mineral ions containing radioactive elements were then supplied to the roots. Soon afterwards all the leaves of the seedling were tested for radioactivity.

It could be expected that radioactivity would be detected

A only in leaves not coated.
B only in coated leaves.
C in both coated leaves and vascular bundles.
D in both leaves not coated and vascular bundles.

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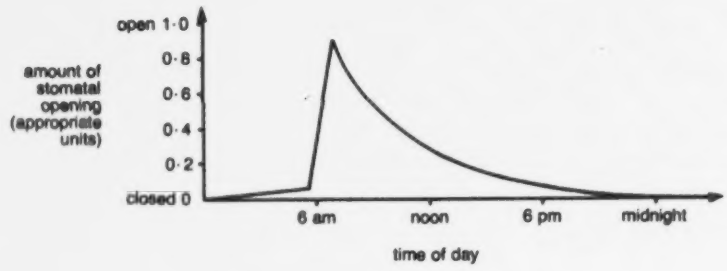
10c-5 – An 3 (c) B The graph below shows typical changes in the stomatal openings in the leaves of a tree during a 24-hour period.



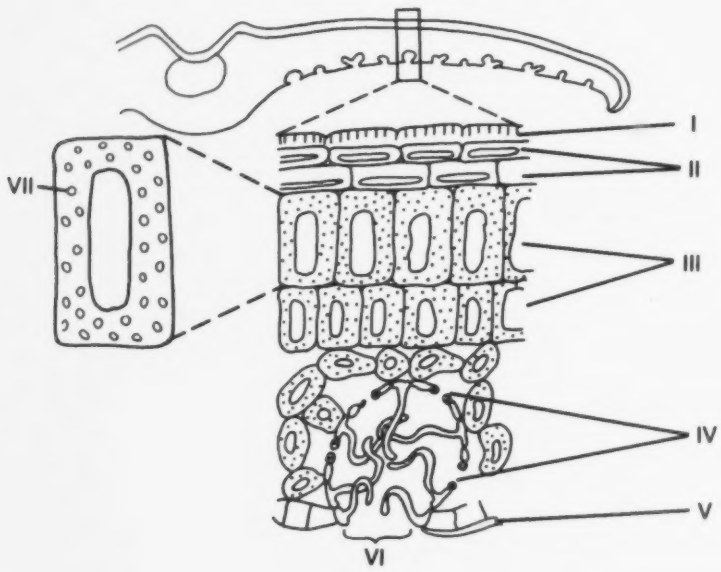
The graph suggests that

A there is more light available for photosynthesis at 8 a.m. than at 12 noon.
B the tree is in a hot dry climate.
C the tree is in a mild climate where water is readily available.
D photosynthesis cannot occur at all during the hot period of the day.

INCORRECT response items

The next 3 items refer to the following information:

The diagram illustrates adaptations of the *Oleander* leaf which enable it to survive in conditions of low water supply.



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10c-6 It is reasonable to assume that

Co 2 (I) A

A structure VI is a stoma.
B layer I is a cuticle.
C layers III are palisade cells.
D structures VII are chloroplasts.

10c-7 The following are adaptations restricting water loss.

Co 3 (I) C

A layer I
B the two layers of structure II
C the two layers of structure III
D hairs inside structure VI

10c-8 An advantage of the double layer of structure III is the extra facility to

Ap 3 (I) D

A absorb light, as light transmission is reduced by layers I and II.
B store water.
C carry out photosynthesis.
D produce carbon dioxide by respiration when stomata are closed.

10c-9 Students measuring the rate of transpiration of a shoot found that hot and windy conditions greatly increased the rate of water loss.

10e An 3 (I) A *

The following hypotheses are supported by such an observation.

A The heat decreases the rate of photosynthesis.
B The hot, windy conditions reduce humidity at the leaf surface.
C The heat and wind cause an increase in stomatal aperture.
D The shoot is not adapted to hot and windy conditions.

Plant Structure—Function Relationships

10d—Transport, storage and waste disposal

CORRECT response items

10d-1 Which of the following is **not** true of the surfaces through which gases exchange in mammals and flowering plants?

Kn 2 (c) D

A Each surface is close to a vascular system.
B Adequate gas exchange is dependent upon constant movement of substances over the surfaces.
C Each surface has a large surface area.
D Active transport occurs through both surfaces.

10d-2 Organisms consist of cells and the products of cells.

Kn 3 (c) B

Which of the following is a cell product?

A leaf epidermis
B leaf cuticle
C root hair
D phloem tissue

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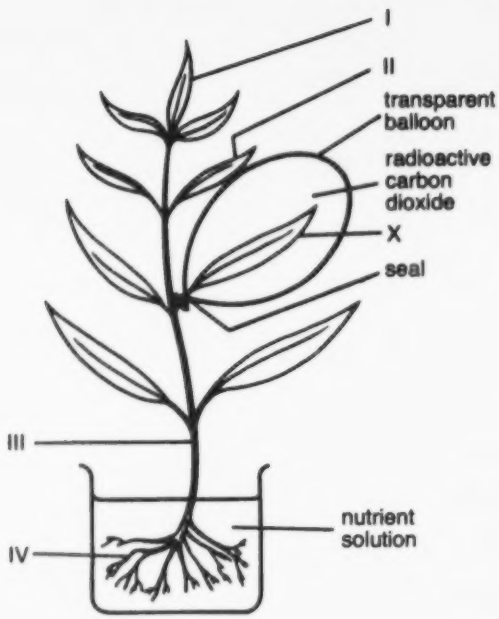
10d-3 A plant was treated as shown below.

–
Ap
2
(c)
D
*



After leaf X had been exposed to carbon dioxide labelled with a radioactive isotope for several hours, sections of tissue, III and IV, were taken from the stem and root respectively, and leaves I and II were removed.

It could be predicted that radioactively-labelled organic compounds would be detected

A in leaf I only.
B in leaves I and II only.
C in sections III and IV only.
D in all the tissues in I, II, III, and IV.

10d-4 Strawberry leaves often show evidence of guttation, a process in which water droplets collect at the outer edges of leaves where veins end.

–
An
3
(c)
D

The length of time during which guttation persists is determined by the weather conditions surrounding the plant.

The table lists some typical garden weather conditions.

	Typical weather conditions in a garden	
	Air temperature (°C)	Humidity (%)
I	6.4	18.3
II	26.7	32.8
III	14.0	94.1
IV	6.5	94.1

Assuming all other conditions remain constant, under which of the sets of conditions in the table would the water droplets persist for the longest time?

A I
B II
C III
D IV

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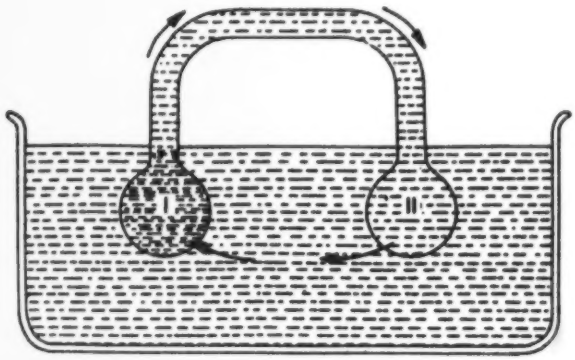
The next 2 items refer to the following information:

The diagram below illustrates the 'mass flow' hypothesis of how substances move through the sieve tubes of the phloem.



Cells I and II have membranes permeable only to water and are immersed in water. Cell I contains sugar solution, cell II water only. The osmotic pressure of the sugar solution draws water through the cell membrane, exerting pressure in the system.

10d-5 Cell I of the model represents one of the following.

17c An 4 (c) A Which one?

A the sugar-manufacturing cells of the leaf
B the growing tissues where sugars are used
C the storage organs where starch is synthesized from sugar
D the sieve tubes of the phloem

10d-6 Several conditions must be present if the flow of solution from cell I to cell II is to continue.

17c An 3 (c) C Which one of the following is **not** an essential condition?

A Sugar must be removed from cell II.
B Sugar must be replenished in cell I.
C The membrane of cell II must be permeable to sugar.
D The concentration of sugar molecules must be higher in cell I than in cell II.

10d-7 – Ap 2 (c) B In an experiment to investigate the movement of liquid in trees, a very small heating element was inserted into the xylem to heat the contents for a few seconds. Two thermocouples were placed at equal distances above and below the heating element to record changes in the temperature of the liquid.

It is expected that a change in temperature would be recorded by

A both thermocouples at the same time.
B the top thermocouple before the bottom one.
C the bottom thermocouple before the top one.
D neither of the thermocouples.

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10d-8 – Ap 3 (c) B A steam jacket is fixed around the trunk of a tree. When steam is passed through the jacket, all living cells in that part of the trunk are killed.

One would expect to find that

A no movement at all occurs past the dead area.
B water and minerals continue to move but carbohydrates do not move past the dead area.
C carbohydrates continue to move but water and minerals do not move past the dead area.
D water, minerals, and carbohydrates continue to move past the dead area.

INCORRECT response items

10d-9 – Co 5 (I) B Although a deciduous tree loses its leaves it survives the winter.

Its survival is aided by

A a small amount of transpiration from buds and bark.
B storage of glucose in certain tissues.
C a reduced rate of cellular metabolism.
D levels of cellular protein being slightly higher than during summer.

10d-10 – Ap 2 (I) B It is possible to 'feed' garden plants with minerals by sprinkling a solution of minerals onto the leaves.

For this method to be successful we must assume that

A leaf cell membranes are permeable to the minerals.
B the concentration of the mineral solution is similar to that of the living leaf cells.
C leaves should remain wet during movement of minerals into the leaf.
D nutrient solution is applied during daylight.

10d-11 – Ap 3 (I) D If a radioactive sugar solution is introduced into a leaf about midway up the stem of a plant, its movement can be traced.

After a given period of time, you would expect radioactivity to be present in high concentrations in the

A growing roots.
B apex of the shoot.
C flower buds.
D leaf tissue.

10d-12 – Ap 3 (I) B The fully-grown leaves of the messmate stringybark (*Eucalyptus obliqua*) each contain about 300 μg of phosphorus. Subsequently the leaves die, and then fall to the ground. At death, the leaves of messmate stringybark each contain about 40 μg of phosphorus.

One might reasonably state that

A phosphorus is moved from fully-grown leaves as they age to other, living parts of the tree.
B the movement of phosphorus from fully-grown leaves occurs within water-conducting vessels.
C younger leaves of the tree obtain part of their phosphorus requirement for growth from the phosphorus which is moved out of the older leaves.
D the amount of phosphorus in an aging, mature leaf could be held constant if a ring of phloem were removed around the leaf stalk.

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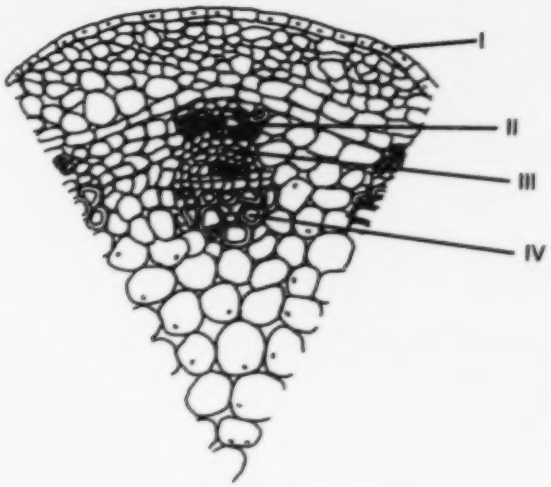
10d-13 The diagram below shows a portion of green, non-woody stem, cut across and showing the vascular bundles.

–
Ap
4
(I)
A
*



It may be reasonably concluded that

A starch would be found in cells of area III.
B a cuticle may be present on layer I.
C areas II and IV would contain lignin.
D cells just below layer I may contain chloroplasts.

10d-14 Transpiration rate and water absorption rate were measured for corn plants over 2-hour periods. The **17k** plants received adequate water and were subject to normal environmental conditions.

An
2
(I)
A

Transpiration Rate and Water Absorption Rate for Corn Plants
(g of water per 2 hour interval)

	Time							
Process	12 p.m. to 2 p.m.	2 p.m. to 4 p.m.	4 p.m. to 6 p.m.	6 p.m. to 8 p.m.	8 p.m. to 10 p.m.	10 p.m. to 12 a.m.	12 a.m. to 2 a.m.	2 a.m. to 4 a.m.
Transpiration	34	45	53	47	27	15	10	5
Absorption	20	31	42	48	35	23	16	11

These results support the following statements.

A Concentration of mineral ions in the leaf guard cells would be greatest at approximately 5 p.m.
B Stomatal pore diameter is dependent on light intensity.
C Absorption of water increases according to demand by the plant.
D The diameter of the stem would be slightly less at 2 p.m. than at 2 a.m.

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Plants and the Environment

10e—Structural adaptations

CORRECT response items

10e-1 – Ap 2 (c) D

The photosynthetic activity of cacti and other desert plants is often greatly reduced during the middle of the day.

The best explanation for this is that

A the enzymes controlling the light reaction are destroyed by the high temperatures inside the plant.

B insufficient water is available to the plant.

C most of the light is reflected by the thick cuticle and is unavailable for photosynthesis.

D the stomata of these plants tend to close at this time.

10e-2 17b Ap 3 (c) A

Charles Darwin studied movements in the leaves of a plant that he called *Oxalis sepium*. He wrote:

> The leaves . . . were observed by me to sleep in a very imperfect manner during the summer, even after the most sunny days: but now, in winter, every leaflet hangs down in a perpendicular position during the whole night.

Which hypothesis best fits Darwin's observations?

A The vertical position of leaflets minimizes exposure to low temperatures.

B The vertical position of leaflets is a response to increasing light intensity.

C The vertical position of leaflets maximizes water loss by transpiration.

D The vertical position of leaflets is a response to increasing air temperatures.

10e-3 – Ap 4 (c) B

Some movement of material in the xylem occurs even in conditions of one hundred per cent relative humidity.

This is because

A liquid moves up the xylem whenever water evaporates from the leaf.

B leaf cells continuously use ions for the synthesis of compounds.

C the energy for transport comes from respiration of glucose.

D organic materials are transported whenever photosynthesis occurs.

10e-4 – An 3 (c) D

Mangroves are plants which grow in tidal mud. In the book *Mangroves of Australia* the authors describe the saline environment thus: '. . . with its intense light and high temperatures and wind it is physiologically quite dry'.

To overcome this, mangrove leaves display a number of structural features including a thick-walled waxy epidermis, salt glands, sunken stomata and well-developed water storage tissue. Transpiration rates in common mangroves are often about one-third those of most land plants.

Which of the following offers the **least** satisfactory explanation for these reduced rates of transpiration?

A The mangrove's stomata close when exposed to bright light.

B A thick-walled waxy epidermis waterproofs the leaves.

C Sunken stomata are less exposed to the air than surface stomata.

D Climatic conditions in the mangrove's environment determine transpiration rates.

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INCORRECT response items

10e-5 Kelp is a large marine brown alga.

10g Co 1 (i) D When comparing kelp with a green land plant, the following points are noted.

- **A** Kelp requires almost continual immersion in sea water for normal development and survival.
- **B** Both plants contain a photosynthetic pigment.
- **C** The land plant experiences greater variations in physical factors of the environment.
- **D** The land plant is better adapted to its environment than the kelp.

10e-6 Water is important to the functioning of the terrestrial angiosperm because

– Co 2 (i) C

- **A** it is used in the manufacture of carbohydrates.
- **B** it reduces overheating, particularly in leaf tissues.
- **C** it carries carbon dioxide from the roots to photosynthetic tissues.
- **D** it assists many species in the support of their soft tissues.

10e-7 – Ap 2 (i) A A common condition of heavily grazed pasture is nitrogen deficiency. Where this occurs, the pasture growth is slow and the colour of the plants is yellowish and pale.

Possible explanations for such deficiency symptoms include

- **A** insufficient nitrogen uptake through the stomata.
- **B** inadequate nitrogen for the manufacture of the chlorophyll molecule.
- **C** insufficient nitrogen for reactions associated with photosynthesis.
- **D** short supply of raw materials for structural proteins.

10f—Germination, growth and reproduction in angiosperms

CORRECT response items

10f-1 – Co 2 (c) A The germinating seed and the mature parent *Eucalyptus* are similar in that they both

- **A** have growing and dividing cells.
- **B** rely on photosynthesis for energy.
- **C** have similar mineral intake requirements.
- **D** require water for support.

10f-2 – Co 2 (c) B Certain grain-producing crops such as maize have seeds which are never photosynthetic at any stage of their development; yet the grains contain large quantities of starch.

Necessary events leading to normal seed development include

- **A** translocation of starch in the phloem.
- **B** joining of sugar units.
- **C** increase of sugars available for overall growth.
- **D** increased mineral uptake during seed development.

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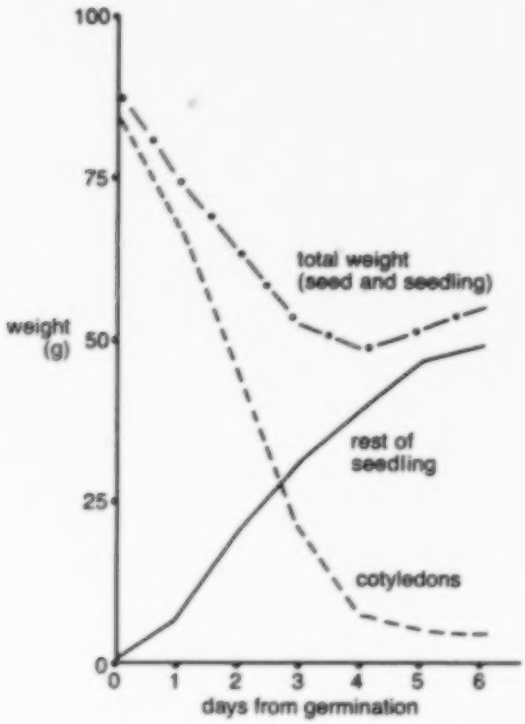
The next 2 items refer to the following information:

The graph shows the weight changes during the germination of a bean seed.



10f-3 Which of the following statements best follows from the data?

–
Co
4
(c)
B

A The cotyledons have lost all their food reserve by day 4.
B The increase in total weight after day 4 is due to photosynthesis.
C By day 3 the rate of total weight loss is greater than the rate of weight loss of the cotyledons.
D By day 7 the total weight will equal the weight of the rest of the seedling.

10f-4 The decrease in total weight over the first four days is most likely due to

–
Ap
4
(c)
A

A respiration of food reserves.
B translocation of sucrose from the cotyledons.
C the growth of the rest of the seedling.
D the transport of water from the seed to the developing shoot.

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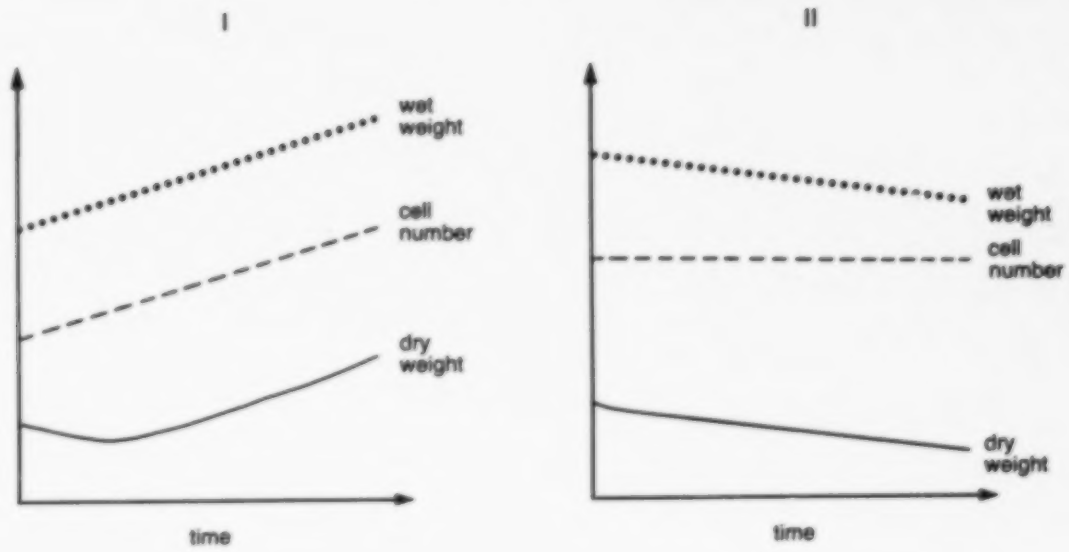
10f-5 – An 2 (c) C The graphs below show the relationship between wet weight, dry weight, cell number and time for two organisms (scales on the vertical axis vary).



Which of the following statements is correct?

A Graph II shows a potato sprouting in a cupboard.
B Graph II shows a deciduous tree losing its leaves.
C Graph I shows a wheat seedling from germination to 10 cm in height.
D Graph I shows a dormant seed on the ground.

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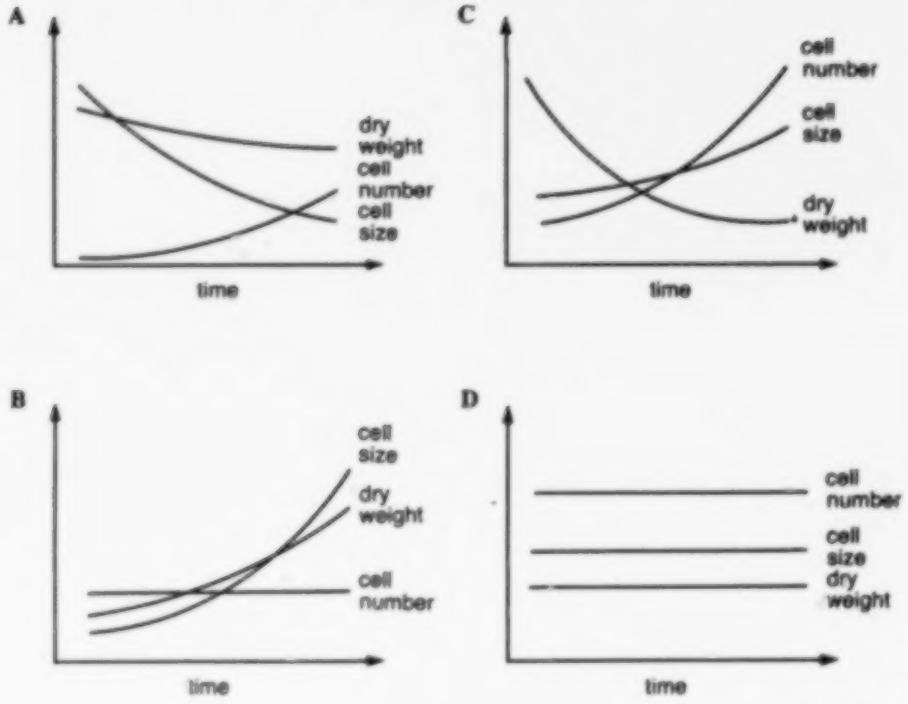
10f-6 Which of the following is an example of seed germination?

–
An
3
(c)
C



INCORRECT response items

10f-7 Whether or not a seed germinates usually depends on the availability of several environmental factors including

–
Kn
2
(I)
C

A oxygen.
B water.
C nutrients.
D temperature.

10f-8 The following statements can be made about the relationship between the fruit and seeds of a plant.

–
Kn
2
(I)
D

A Fruit develops from the ovaries of a flower and seeds develop from the ovules.
B Fruit helps protect the developing seed from desiccation.
C Seeds usually develop inside the fruit.
D Fruit provides food for the seeds it contains.

10f-9 The vascular cambium in woody dicotyledonous plants is responsible for

–
Kn
2
(I)
A

A transporting raw materials around the plant.
B producing specialized cells for the xylem and phloem.
C increasing the width of the stem or trunk.
D forming the growth rings in a tree trunk.

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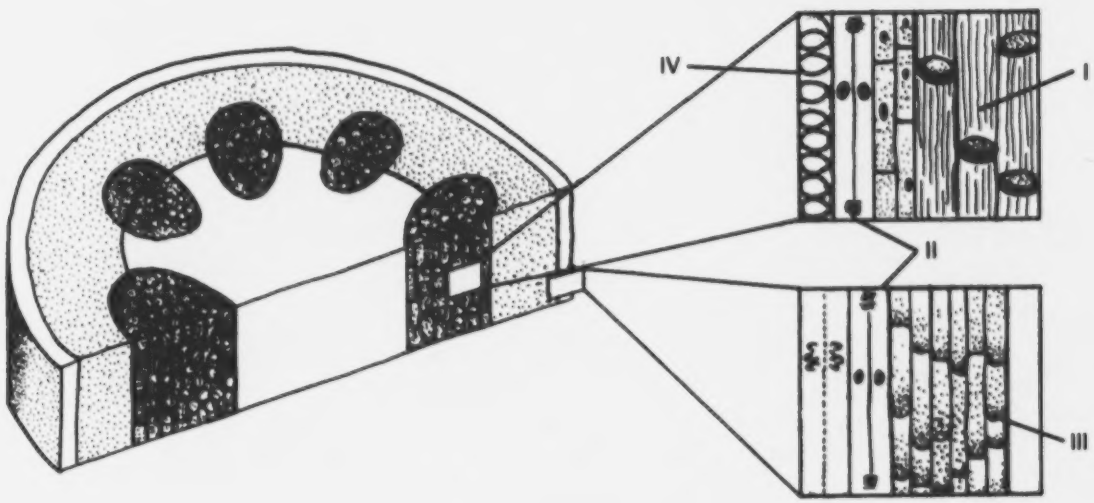
10f-10 – Kn 3 (I) D The diagram is of a region from the stem of a woody flowering plant, and shows two longitudinal sections of tissues prepared from different parts of the stem.



The function of each tissue numbered in the diagram is as follows.

	Tissue	*Function*
A	I	transporting sugars
B	II	providing new tissues
C	III	protecting the plant
D	IV	storing carbohydrates

10f-11 – Co 3 (I) B It has been demonstrated that seeds of a species of Lupine found by biologists in frozen ground in the Arctic, and estimated to be over ten thousand years old, will germinate when placed on moist, warm soil.

Seeds are capable of remaining dormant for such long periods of time and under adverse environmental conditions.

This is possible because

A seeds contain a food reserve.
B a seed does not respire.
C the embryo is protected by the seed coat.
D there is very little cell division in a seed.

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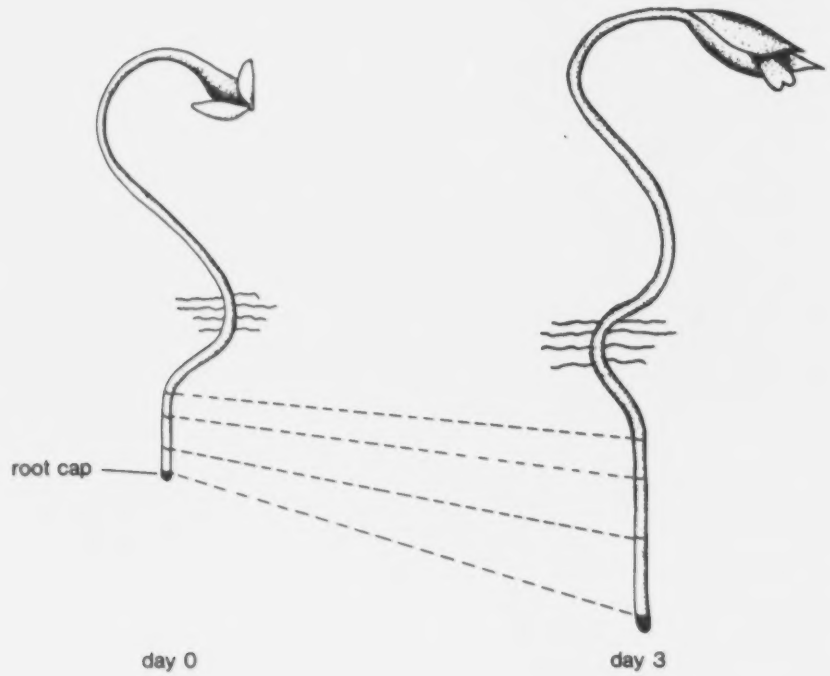
10f-12 – Co 2 (I) B As the diagram indicates, the root of a bean seedling is marked at three equal intervals from the root cap on day 0, and the changes to each interval are observed on day 3.



The increase in root length after three days is due to cells

A multiplying in number.
B becoming more specialized.
C increasing in length.
D growing in volume.

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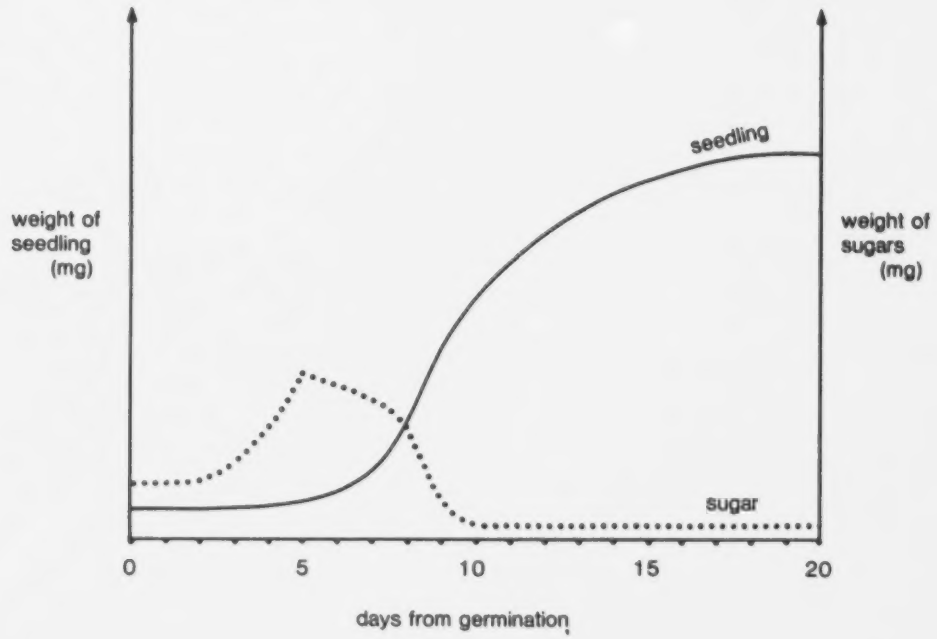
The next 2 items refer to the following information:

The graphs describe the change in weight shown by a seedling for 20 days from the onset of germination, and the corresponding change in the amount of sugars stored in the endosperm during this time.



10f-13 Between days 8 and 12 there is likely to be an increase in

–
Ap
3
(i)
C

A cell division and cell enlargement.
B the transport of sugars.
C the synthesis of sugars.
D the breakdown of sugars.

10f-14 Events taking place by day 20 would include

–
Ap
3
(i)
D

A a slowing down of growth in the meristematic zones.
B the commencement of photosynthesis.
C the storage of sugars.
D the completion of cell differentiation.

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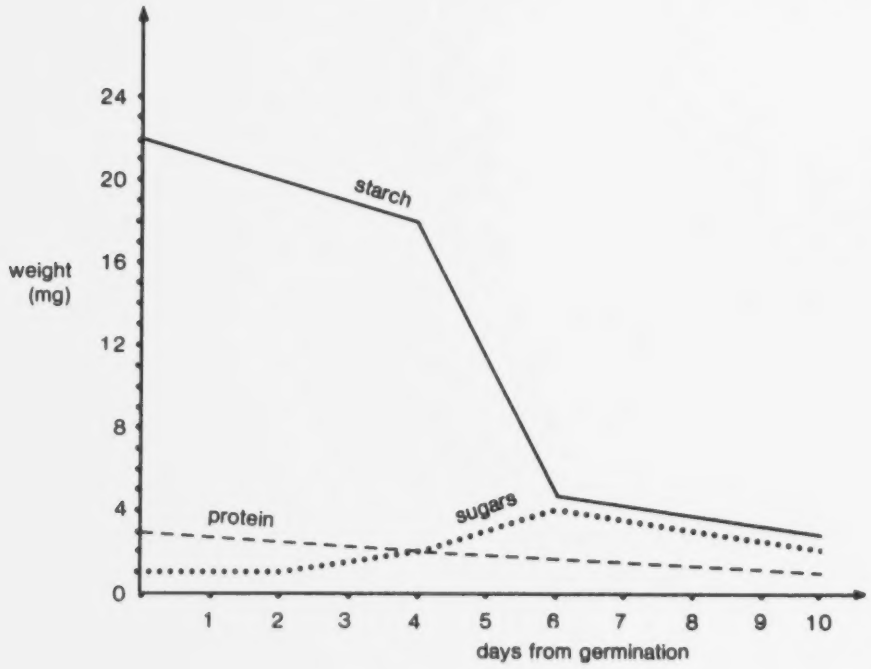
The next 2 items refer to the following information:

The graphs indicate the changes to the amounts of starch, protein and sugars in the endosperm of a wheat seed for a period of 10 days following germination.



10f-15 Within six days of germination there has been

Co2(l)A

A no translocation of sugars to the growing regions.
B a constant decrease in the amount of protein.
C an increase in the breakdown of starch to sugars.
D an increase in the amount of sugar stored in the endosperm.

10f-16 Of the overall changes which occur during the 10 days

An4(l)C

A the highest rate of sugar storage occurs between days 4 and 6.
B starch reserves are depleted more rapidly than sugar reserves.
C the decrease in weight of protein is greater than the decrease in weight of sugar.
D there is always some translocation of sugars to growing regions.

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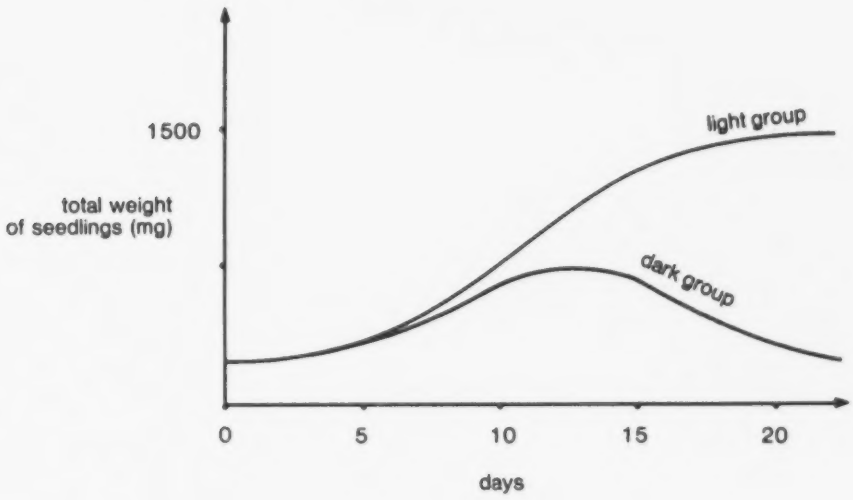
The next 2 items refer to the following information:

Two groups of day-old wheat seedlings, equal in number and weight, and germinated from the same batch of grain, were grown on moist cotton wool in the laboratory for a period of 20 days. One group grew in the dark, the other grew in the light. Throughout the experiment both groups were supplied with a constant amount of water with the necessary mineral nutrients, and kept at 24 °C. Both groups were weighed at regular intervals and the results are indicated in the graphs.



10f-17 For the two groups on day 5 you could reasonably conclude that

An 4 (I) B

A seedling growth initially relies almost entirely on food reserves in the endosperm.
B photosynthetic tissues have begun to form by day 5.
C provided sufficient food is available, seedlings are able to take up mineral ions in the dark.
D cellular respiration occurs equally as well in the dark as in the light.

10f-18 Possible factors contributing to the weight loss of seedlings in the dark after day 5 are that

An 3 (I) C *

A cellular respiration has depleted the food reserves.
B diffusion of oxygen into the leaves was restricted.
C diffusion of carbon dioxide into the leaves was restricted.
D mineral ions could not be taken up in sufficient quantity.

10g—Adaptation, efficiency and inheritance

CORRECT response items

10g-1 Which one of the following **best** describes the function of root hairs?

Kn 1 (c) D

A They add to the length of the root by repeated cell division.
B They provide anchorage for the root.
C They protect the delicate surface cells of the elongating root.
D They provide a large surface area for absorption.

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10g-2 Which of the following would **not** be an adaptation for plants living in low rainfall areas?

– Co 1 (c) D

A hairy leaves
B short life cycle
C very small leaves
D many stomata

10g-3 When the stem of a mature flowering plant was examined under the microscope, it was found to have large intercellular spaces and very few cells whose walls contained lignin.

– Co 2 (c) B

The plant was **most** likely to have been growing

A on a rocky surface.
B in a lake.
C on a tree in a tropical forest.
D in soil.

10g-4 Flowering plants which grow submerged in water are likely to differ from closely related land-living species in having

– Co 3 (c) A

A less xylem.
B larger leaves.
C fewer chloroplasts.
D brighter flowers.

10g-5 Trees growing in dense forest areas tend to be taller and straighter than those of the same species growing in open areas.

– Co 4 (c) C

Which if the following is **least** likely to account for this difference?

A The root system penetrates more deeply in forest areas to compete for the limited nutrient supply.
B Competition for light in forest areas causes the trees to develop longer trunks.
C The proximity of other trees in the forest restricts the development of lateral branches.
D The outermost trees offer protection from the wind for other trees within the forest.

10g-6 The large flat leaves of *Nymphaea* plants have stomata only on the upper surface.

– Ap 2 (c) A

Nymphaea is most likely to be found growing

A in a shallow pond.
B in heavy shade.
C on the bark of a tree.
D on a rocky slope.

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INCORRECT response items

10g-7 With deciduous trees in late autumn you would expect to find
–
Co
1
(I)
C

A leaves in which there is little if any photosynthetic activity.
B an accumulation of waste materials within each leaf.
C an intake of nutrients by each leaf.
D swollen cells at the base of each petiole.

10g-8 Certain plants are well adapted to arid conditions and have features which reduce excessive water loss.
10e
Co
2
(I)
D

Such features include

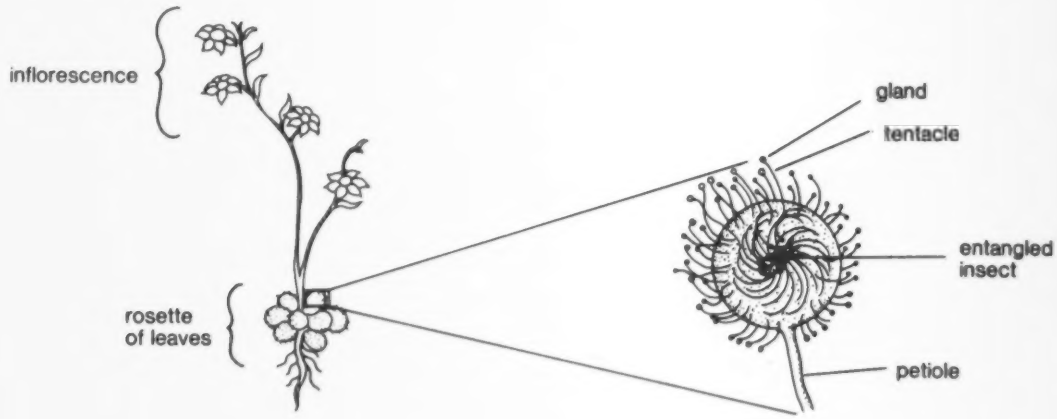
A a shiny cuticle layer on the leaf surface.
B thick, fleshy leaves.
C stomata located in depressions on the leaf surface.
D a large leaf canopy to shade the root area.

10g-9 Some species of plants have leaves which are covered in fine hairs.
10e
Co
3
(I)
A

Some effects of these hairs would include

A greater water loss per leaf because of the increased surface area due to the hairs.
B decrease in photosynthetic efficiency of the leaves due to shading effects of the hairs.
C slowing down movement of air over the leaf surface.
D a decrease in the rate of water uptake by the plant.

10g-10 Insectivorous green plants such as the sundew (*Drosera rotundifolia*) have leaves which are highly modified to attract and capture prey. As shown in the diagram, a leaf of the sundew bears numerous hair-like tentacles at the tips of which are glands which secrete a sticky fluid. The diagram also illustrates how the surrounding tentacles close over and entangle an insect once it becomes trapped in the sticky fluid.
–
Ap
3
(I)
D



It is likely that plants such as the sundew

A secrete digestive enzymes.
B have active translocation.
C can grow in soils deficient in certain nutrients.
D do not make their own food.

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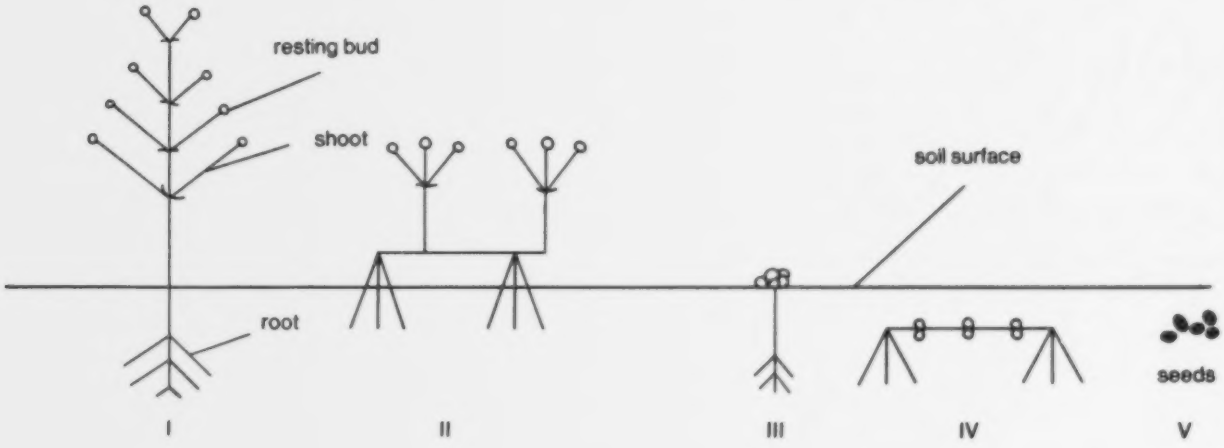
The next 3 items refer to the following information:

Angiosperms consist of a number of growth forms, ranging from large woody trees to minute herbs. These forms can be classified into five groups depending on the length of life of the shoots and the position of the resting buds. The different groups are described and illustrated as follows:

Group	Description
I	persistent shoots and buds carried well above the soil surface
II	resting buds close to the soil surface
III	resting buds at the soil surface
IV	resting buds below the soil surface
V	plants that withstand unfavourable periods as embryos in seeds



A study which investigated the percentage distribution of each group in plant communities at five localities of increasing latitude (and of approximately equivalent altitude) produced the data given in the table below.

Location	Approximate latitude	Percentage representation I	II	III	IV	V
Amazonian rain forest	0	95	1	3	1	0
West Indies	18 °N	58	12	9	3	14
Denmark	57 °N	7	3	50	22	18
Iceland	65 °N	2	13	54	20	11
Spitsbergen Island (Arctic Ocean)	80 °N	1	22	60	15	1

10g-11 From the information in the tables it is possible to make the following conclusions.

– Co 2 (I) B

A Large, woody angiosperms are more suited to the warmer climates.
B There are more group V angiosperms the further north one goes.
C Plants belonging to group III are the dominant angiosperms in localities north of the West Indies.
D The highest incidence of plants below the soil surface occurs in Denmark.

10g-12 You could reasonably conclude from the data that

– An 3 (I) C

A group I angiosperms would harness the most solar energy.
B plants belonging to group V are annuals.
C angiosperms in group IV compete with group III plants for light.
D group II plants are capable of reproducing asexually.

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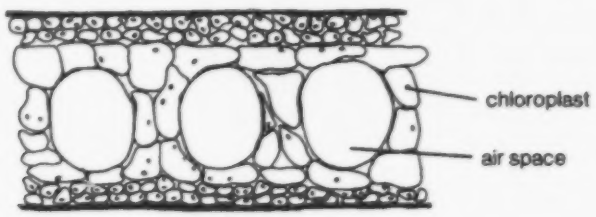
10g-13 A factor likely to be important in the survival of group IV angiosperms in the arctic would be the ability to

An
4
(I)
D

A undergo a period of rapid growth in the shoots and roots.
B produce flowers, fruit and seeds in a relatively short time.
C withstand long periods without water.
D produce additional root cells in winter.

The next 2 items refer to the following information:

During a practical exercise, a student was required to examine a leaf of a plant from an unknown habitat. On observing tranverse sections of the leaf under a microscope, the student noticed that there were no stomata, and that massive, membrane-bound air spaces were present at regular intervals along each section. The student also noted that a thin cuticle covered both surfaces, and chloroplasts were far more abundant in the cells of the epidermis than in the very reduced mesophyll layer; also there were no obvious intercellular spaces in either layer. The student drew a diagram of a typical section of the leaf as follows:



10g-14 It is likely that the plant from which the leaf came

Ap
3
(I)
C

A relies on gaseous diffusion through the cuticle.
B grows where there is reduced light intensity.
C is fully protected against water loss.
D grows in an aquatic habitat.

10g-15 It is likely that the air spaces

An
4
(I)
B

A assist in the support of the leaf in its habitat.
B are sites of gas exchange between leaf cells and the environment.
C store gases involved in respiration and photosynthesis.
D help maintain the shape of the leaf.

10g-16 Herbaceous (non-woody) plants will wilt if soil water is in short supply.

Co
3
(I)
A

Observations made on a wilting plant would reveal that

A storage cells in the stem contain large vacuoles.
B stomatal aperture is less than normal.
C photosynthetic activity is altered.
D cell membranes have contracted away from cell walls.

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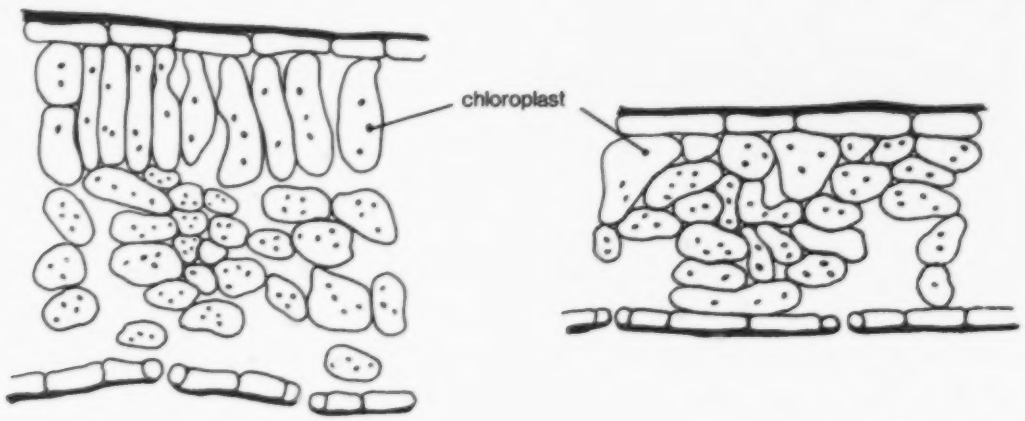
10g-17 10e Ap 2 (I) B

Desert-dwelling plants, when compared with plants of the same genus from the wetter coastal areas, probably have

A leaves with thicker cuticles.
B more intercellular spaces within the leaves.
C a larger and more extensive root system.
D stomata set within depressions on the leaves.

10g-18 – An 3 (I) B

A biologist selected two similar plants of a species of angiosperm and grew them under conditions so that each plant received a different amount of sunlight. Plant I received full sunlight, plant II received only seven per cent sunlight. Both plants were grown in the same type of soil, and received equal amounts of water and the necessary mineral ions. At the end of the experiment, transverse sections were prepared from the leaves of each plant and viewed under a microscope. The features seen in a typical section for each plant are illustrated below.



Plant I Plant II

It is reasonable to suggest that

A there is less water lost from plant II than from plant I.
B the rate of photosynthesis is less than the rate of respiration for plant II.
C both plants I and II are functionally efficient despite differences in light intensities.
D plant I would produce more sugars than plant II in a given interval of time.

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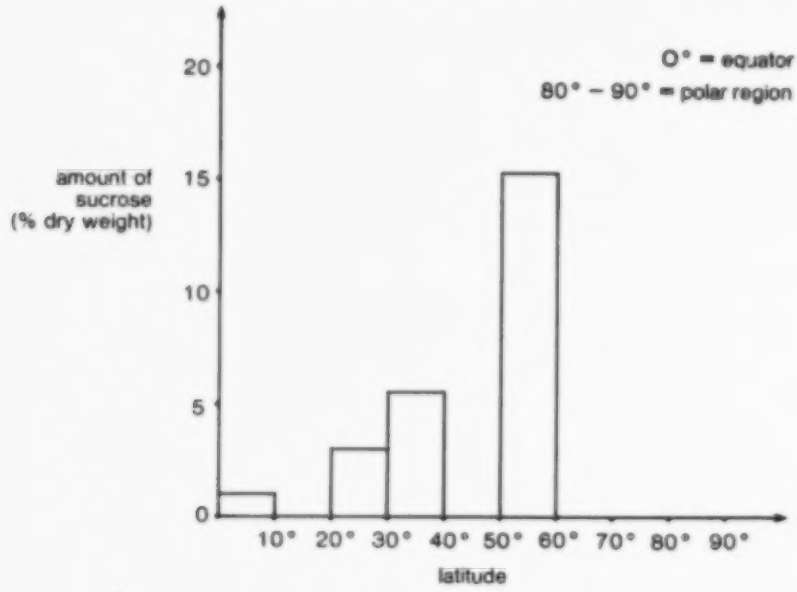
10g-19 17b An 4 (I) B

Sucrose is an important soluble carbohydrate in all plants but particularly in sea-grass, a marine angiosperm that occurs in the shallower waters of oceans throughout the world. A biologist investigating the relationship between latitude and the amount of sucrose (estimated as percentage dry weight) in the leaves of sea-grass recorded the data presented in the graph below.



A suitable hypothesis to explain these data would be that

A sea-grass growing nearer the equator has a higher rate of metabolism than sea-grass growing in the higher latitudes.

B less carbon dioxide enters photosynthetic cells in sea-grass in the colder zones.

C sea-grass grows faster in the tropics than in the colder zones.

D the rate at which sugar is translocated in the phloem of sea-grass decreases with latitude.

10g-20 – An 4 (I) B *

It is very common for trees from the more temperate regions of the world to shed their leaves before the onset of winter and to grow new leaves in the spring. An interesting variation to this theme is seen in the vine cactus (ocotillo) which inhabits the North American desert. The cactus remains leafless for most of the year, except for when it rains. When this occurs the cactus comes out in leaf only to shed its leaves shortly after the rain stops. It appears that for the vine cactus at least, the frequency of leaf fall and leaf regeneration is in some way associated with the frequency of rain.

Within its desert environment, what advantages might there be for the vine cactus to shed its leaves and then regenerate them whenever it rains?

A to reduce the amount of water lost through transpiration

B to decrease cellular respiration, and to thereby conserve food reserves

C to coincide maximum photosynthetic activity with availability of resources

D to remove toxic waste products accumulated during times of drought

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The next 2 items refer to the following information:

Mangroves are found growing in the intertidal zones around much of Australia's coastline. One problem faced by the mangrove is coping with a highly saline environment while at the same time obtaining sufficient water to meet its needs. The mangrove is required to take in water from surroundings in which the concentration of salts is much greater than in its root cells. Another problem is obtaining sufficient oxygen for the root cells, for even at low tide the root system of the mangrove may be immersed in sea-water.

10g-21 – An 4 (I) A Several factors exist which enable the mangrove to meet its water requirements. These might include the plant

- **A** being able to decrease its transpiration rate.
- **B** having root cells which are able to expend energy to take in water against a concentration gradient.
- **C** being able to concentrate salts in its root cells at a level higher than in the sea-water.
- **D** having specialized tissues to excrete salt.

10g-22 – An 4 (I) C Because of evaporation, the salt concentration at low tide in the mangrove's environment is often higher than at high tide. A likely way for the mangrove to cope with an excessive intake of salt would be to

- **A** remove excess salt through special glands in the leaves.
- **B** store excess salt in specialized tissues.
- **C** lose excess salt through the root cells by diffusion.
- **D** take in more water through its root system.

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11 FUNCTION AND STRUCTURE IN ANIMALS

Input and Output

11a—Structure and function in organs and systems

CORRECT response items

11a-1 The human intestine carries out all of the following functions **except** one.

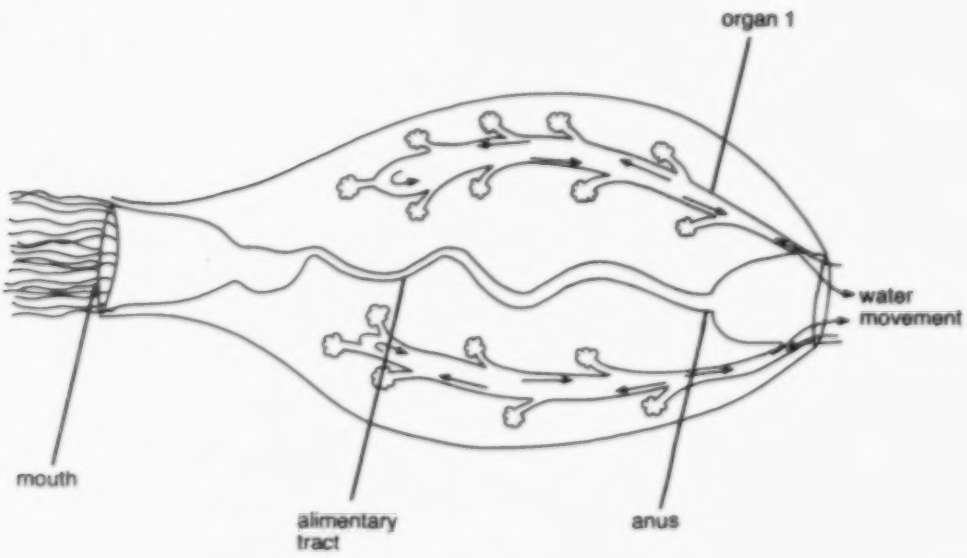
11b
Kn
4
(c)
C

Which one?

A the secretion of digestive juices
B the absorption of vitamins
C the digestion of bile
D the hydrolysis of DNA

11a-2 The diagram represents a sea cucumber.

–
Co
2
(c)
D
•



The organ marked I in the diagram is most likely to be part of the animal's

A circulatory system.
B nervous system.
C digestive system.
D respiratory system.

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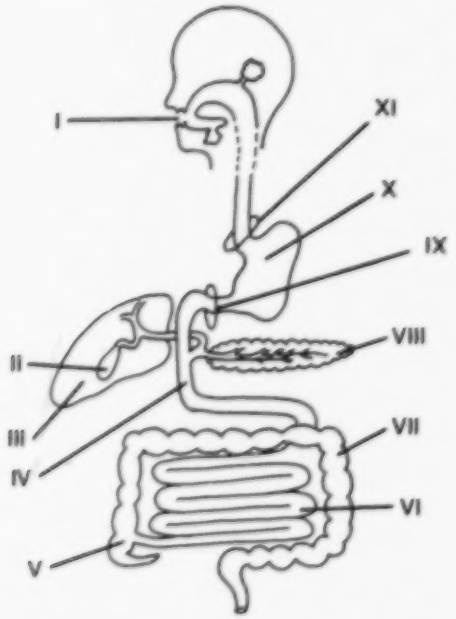
INCORRECT response items

11a-3 – Kn 4 (i) C Each of the following substances is a waste product and must be excreted from the organs indicated.

A bile salts from the rectum
B carbon dioxide from the lungs
C cellulose fibres from the rectum
D urea from the bladder

The next 2 items refer to the following information:



11a-4 – Kn 2 (i) A The following functions are carried out by each of the various structures as indicated.

	Structure	*Function*
A	II	produces digestive enzymes
B	III	receives nutrients from the small intestine via the blood
C	VI	absorbs small food molecules
D	VII	removes water from undigested food

11a-5 – Co 1 (i) B Each of the numbered structures matches up with a particular function as shown.

	Function			
	Release enzymes	*Mechanical and chemical digestion*	*Breaking down and absorbing food*	*Regulation of the passage of food*
A	VIII	X	VI	IX
B	VI	VII	V	X
C	VI	I	X	XI
D	X	IV	VI	IX

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11b—Digestion, absorption, assimilation storage and elimination

CORRECT response items

11b-1 The main function of the villi of the small intestine is to

–
Kn
1
(c)
B

A secrete juices which aid the digestion process.
B provide a large surface for the absorption of digested food.
C provide a storage area for digested food.
D aid in the mechanical digestion of food.

11b-2 Which of the following alternatives best distinguishes between the blood vascular system and the lymphatic system of mammals?

–
Kn
2
(c)
B

	Blood vascular system	*Lymphatic system*
A	open system, only transports nutrients	open system, only transports wastes
B	closed system, pumping organ present, valves present in vessels	open system, no pumping organ, valves present in vessels
C	closed system, no pumping organ, no valves in vessels	closed system, no pumping organ, no valves in vessels
D	open system, relies on cardiac muscle contraction for blood flow	open system, relies on skeletal muscle contraction for blood flow

11b-3 From which one of the following is the waste product urea formed?

–
Kn
2
(c)
D

A fat
B sugar
C glycerol
D protein

11b-4 In man, bile

–
Kn
3
(c)
C

A is produced in the gall bladder.
B contains enzymes which act in conjunction with lipases.
C contains salts which emulsify fats to form small globules.
D chemically digests fats into fatty acids and glycerol.

11b-5 In man most of the end-products of the digestion of fats pass into

–
Kn
4
(c)
B

A the large intestine.
B lymph vessels in the intestinal villi.
C capillaries in the intestinal villi.
D the bile duct.

11b-6 Intestinal absorption of some substances is an active process.

–
Co
2
(c)
C

This means that

A the villi must actually move to enable molecules of food to be absorbed by pinocytosis.
B products of digestion diffuse quickly across the membranes.
C energy is expended for the absorption of some substances against a concentration gradient.
D the absorption of some substances occurs most readily when there is maximum movement of the intestines.

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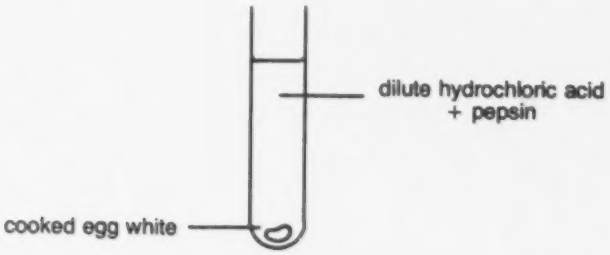
The next 3 items refer to the following information:

The following experiment was set up to investigate the action of the stomach protease, pepsin.



11b-7 One week later there was **no** visible change in the egg white.

17b Kn

The best reason for this is that

3

(c)

A

A temperatures were inappropriate.

B egg white does not contain protein.

C the enzyme pepsin is denatured by light.

D egg white requires chemical digestion in the mouth to prepare it for digestion in the stomach.

11b-8 The student wanted to detect traces of the end products of digestion of egg white by pepsin.

17d Kn

He should analyse the solution for

1

(c)

C

A fatty acids.

B simple sugars.

C amino acids.

D vitamin B.

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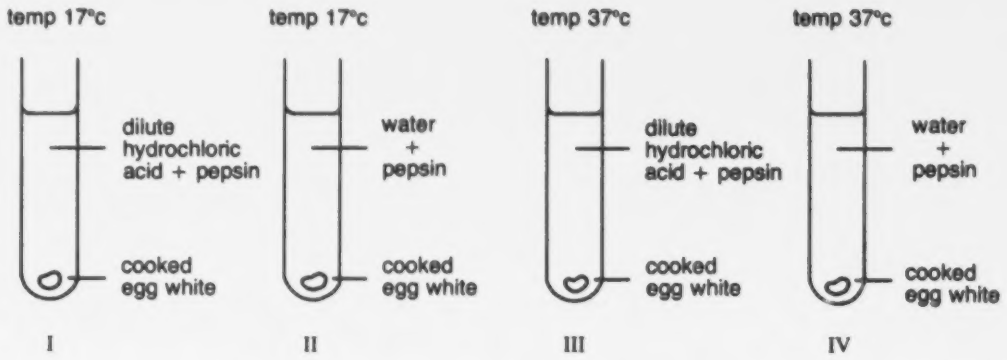
11b-9 An experiment was set up as shown.
17d
Kn
1
(c)
C



In which tube will the egg white be digested most quickly?

A I
B II
C III
D IV

11b-10 A fat-free diet can still lead to an increase in fat storage in body tissue.
–
Co
2
(c)
C

Of the following statements, which one best explains how this storage occurs?

A Fat is the most useful storage compound since one gram of fat provides more energy than one gram of carbohydrate.
B Fat is a useful storage compound since, on hydrolysis, it is broken down to glycerol and fatty acids.
C Carbohydrates are broken down to sugars, and body processes convert excess sugar to fat.
D Only small amounts of carbohydrates are stored as glycogen.

INCORRECT response items

11b-11 Chemical digestion of food in the alimentary canal depends on
–
Kn
2
(l)
C

A increasing surface area of the food material by physical breakdown.
B maintaining different sections of the pathway at specific pH values.
C effective reabsorption of water by the large intestine.
D the activity of a variety of glands in the canal walls.

11b-12 Absorption of digested food materials takes place in the following ways.
–
Kn
3
(l)
A

A Fatty acids are absorbed by the blood capillaries of the villi in the small intestine.
B Some mineral ions and simple sugars are absorbed through the stomach wall.
C Glucose is absorbed through the wall of the stomach or small intestine and is carried in the blood stream.
D Amino acids are absorbed through the wall of the duodenum.

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The next 2 items refer to the following information:

In mammals, the activities of various parts of the digestive system are partly controlled by the endocrine system.

A summary is given in the table.

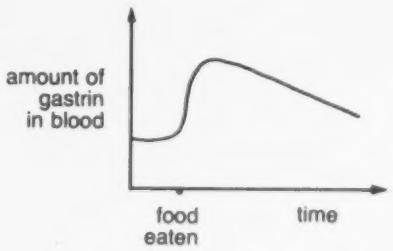
Part of digestive system	Stimulus	Secretion	Action
Cells in stomach lining	Food in stomach	Gastrin	Stimulates pancreas to release pancreatic juice
Cells in epithelium of small intestine	Food in small intestine	Secretin	Stimulates pancreas to release pancreatic juice
Cells in epithelium of small intestine	Food in small intestine	Cholecystokinin	Stimulates gall bladder to release bile
Cells in epithelium of small intestine	Food in small intestine	Enterogastrone	Inhibits acid production in the stomach

11b-13 The following graphs are consistent with the above information.

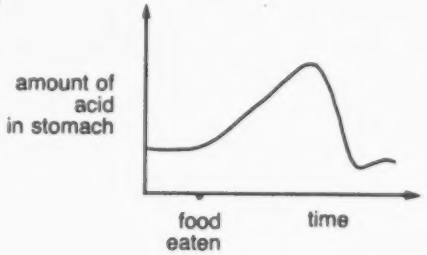
–
An
3
(I)
D

(Time scale is the same on each graph.)

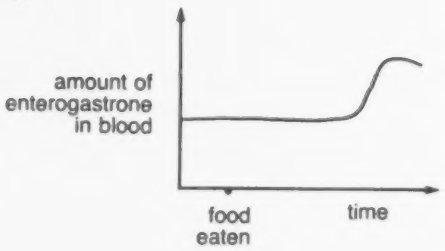
A



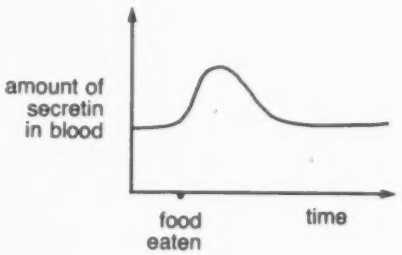
C



B



D



11b-14 The following statements are consistent with the above information.

–
An
3
(I)
A

A A quantity of gastrin will itself be digested in the stomach before it reaches the pancreas.

B Once food has entered the small intestine, the acidity of the stomach contents will decrease.

C The above secretions are controlled by feed back mechanisms.

D Secretion of pancreatic juice will occur even if food is prevented from moving from the stomach into the small intestine.

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11b-15 – Co 2 (I) B

In the process of mammalian digestion, each of the following digestive actions has commenced by the time food is about to leave the stomach.

A the breakdown of starch to sugars through the action of saliva
B the breakdown of fats to fatty acids and glycerol through the action of bile salts
C the breakdown of proteins to polypeptides through the action of gastric juice
D the coagulation of soluble milk protein through the action of renin

11b-16 – Co 4 (I) A

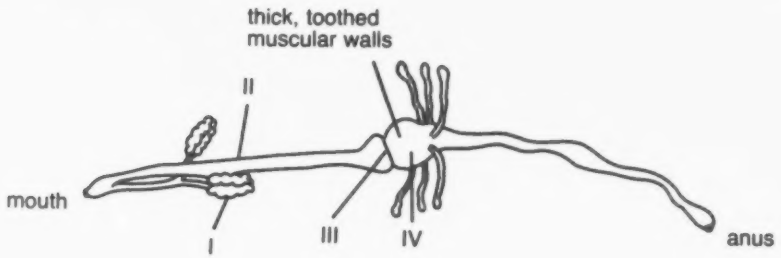
Shortly after digestion is complete, small food molecules pass into the bloodstream from the small intestine.

As a consequence, one would expect to find

A a high concentration of protein in veins leading to the liver.
B similar amino acid content in blood entering and leaving the right ventricle.
C a high concentration of glucose in veins leading to the liver.
D little if any glycerol or fatty acids in veins entering the liver.

11b-17 – Ap 2 (I) A

The following diagram is of the alimentary canal of an invertebrate animal which has a range of diets very similar to that of man.



It would be reasonable to suppose that

A structure II will have many tiny finger-like projections on its interior surface.
B structure III will prevent the backflow of food in the alimentary canal.
C if structure I fulfils a function similar to that of human salivary glands then it would secrete an amylase and mucus.
D structure IV is involved in the mechanical digestion of food.

11c—Respiratory systems and surfaces, gaseous exchange

CORRECT response items

11c-1 – Ap 1 (c) A

Some frogs breathe by vibrating the skin at the bottom of their mouth.

In man the structure that performs a similar function is the

A diaphragm.
B alveoli.
C lung.
D tongue.

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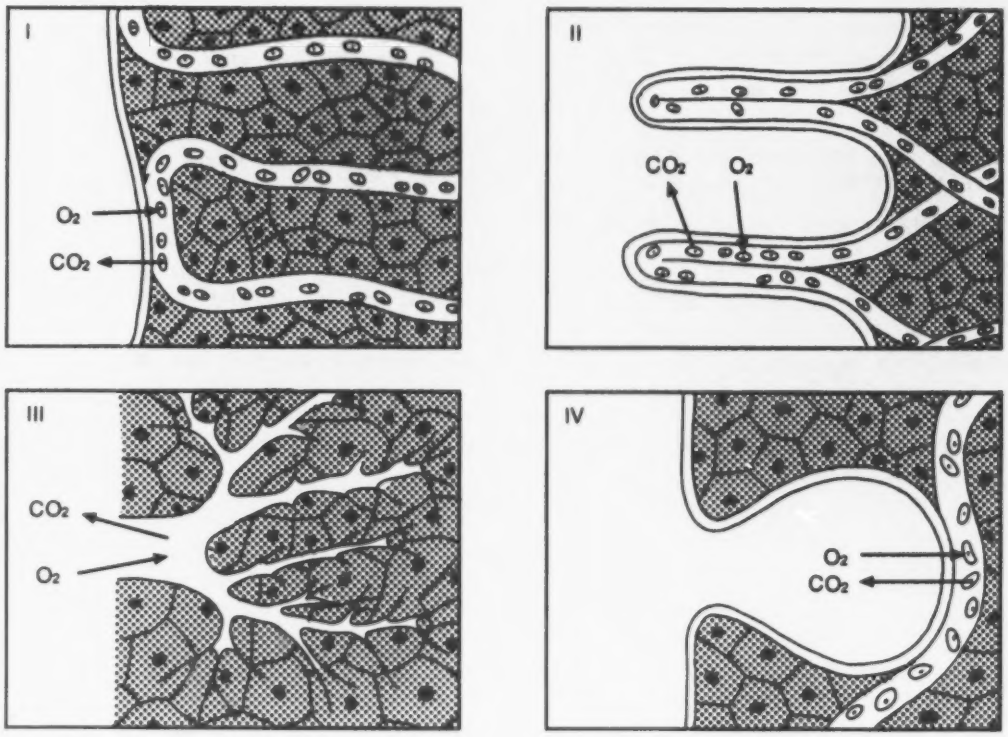
11c-2 – Co 4 (c) D The following diagrams represent four types of surface over which exchange of gases takes place.



Which group of animals is most likely to have the surface indicated?

	I	II	III	IV
A	Snake	Cat	Emu	Tadpole
B	Amoeba	Crayfish	Grasshopper	Elephant
C	Earthworm	Yabbie	Rabbit	Dolphin
D	Skin of frog	Goldfish	Ant	Magpie

INCORRECT response items

11c-3 11a Co 2 (I) C Both the lung and small intestine of terrestrial mammals have similar structures related to similar functions.

These can be described as follows.

- **A** a large surface area enabling rapid diffusion of materials between the external and internal environment
- **B** a dense network of blood capillaries to transport materials to and from the organ
- **C** thick layers of muscle to control the movement of the organ
- **D** a thin surface lining to separate external and internal environments

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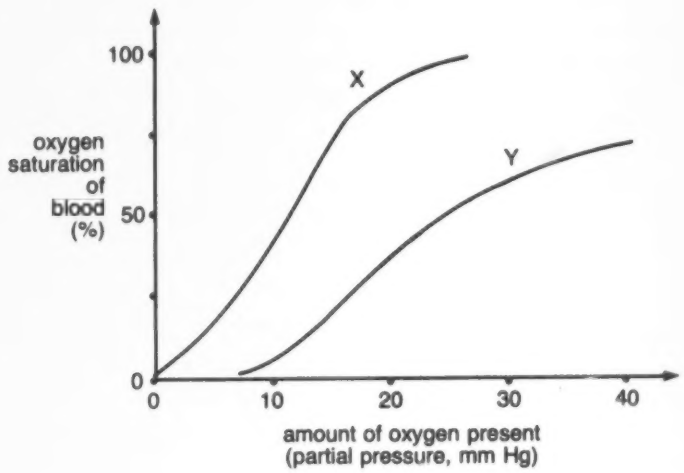
The next 2 items refer to the following information:

The relative oxygen saturation of the blood of the frog at various concentrations of oxygen (represented by oxygen partial pressure in mm Hg) is given in the diagram below.

Curve X—frogs 'X' were placed in an environment with little carbon dioxide present and the oxygen concentration was varied.

Curve Y—frogs 'Y' were placed in an environment with a high carbon dioxide concentration and the oxygen concentration was varied.



11c-4 An 4 (I) C Using the above information and your knowledge of gas transport, it seems reasonable to say that

A the blood of frogs 'Y' would have a lower pH than frogs 'X'.

B at a partial pressure of 20 mm Hg, blood of frogs 'X' is carrying more oxygen than blood of frogs 'Y'.

C the bicarbonate ion concentration of the blood of frogs 'X' would be greater than that of frogs 'Y'.

D in the blood of the capillaries lining the lung surfaces of both groups of frogs, many bicarbonate ions are being converted to carbonic acid and then to carbon dioxide and water.

11c-5 17b An 4 (I) A * The following statements appear to be justified from the experimental results described above.

A In capillaries, when carbon dioxide enters frog blood, more haemoglobin molecules combine with oxygen than at lower carbon dioxide levels.

B In environments with high carbon dioxide levels, the oxygen pressure at which haemoglobin becomes saturated with oxygen is higher than it is in environments with low carbon dioxide levels.

C In the tissues of the frog, addition of carbon dioxide facilitates the unloading of oxygen.

D In environments with high carbon dioxide levels, more oxygen is required to saturate the same number of haemoglobin molecules than in a low carbon dioxide environment.

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11d—Mammalian excretion maintains a constant internal environment

CORRECT response items

11d-1 In mammals, urea is normally present in

–
Kn
2
(c)
A
*

A high concentrations in urine compared with those in plasma.
B high concentrations in glomerular filtrate but in low concentrations in urine.
C the same concentration in glomerular filtrate and in urine.
D high concentrations in glomerular filtrate compared with those in plasma.

11d-2 The average concentration of sodium ions in the human bloodstream is 0.8 g/L. If extra sodium chloride is added to the diet, then homeostatic mechanisms operate on the excess.

–
Kn
2
(c)
B

The excess will be

A stored in the liver.
B excreted in the urine.
C reabsorbed into the bloodstream.
D broken down by enzyme action.

11d-3 The filtrate in Bowman's capsule contains many substances such as water, urea, glucose and ions. Some of these substances are not present in the urine of a healthy person.

–
Kn
2
(c)
A

The most likely reason is that

A useful substances are reabsorbed into capillaries surrounding the kidney tubule.
B the smallest molecules are deposited in the walls of the kidney tubules.
C all useful substances are further filtered by Bowman's capsule.
D the smallest molecules are reabsorbed into the glomerulus.

11d-4 Which of the following compounds would **not** be found in the Bowman's capsules of a healthy person?

–
Kn
2
(c)
C

A water
B glucose
C haemoglobin
D urea

11d-5 Which of the following is **not** considered as being excreted from the mammalian body?

–
Kn
3
(c)
B

A carbon dioxide
B faecal matter
C urea
D sweat compounds

11d-6 Consider the hypothesis that the cells forming the walls of renal tubules actively absorb glucose by a process involving the expenditure of energy.

–
Co
3
(c)
C

Which one of the following most strongly supports this hypothesis?

A Glucose may be present in the urine almost immediately after a meal rich in carbohydrates.
B The amount of glucose present in the tubule fluid becomes progressively less as the fluid passes along the tubule.
C Glucose is absorbed even if the concentration of it in the tubule fluid is less than the concentration of it in the blood.
D People suffering from an abnormally high blood glucose concentration frequently have a considerable concentration of glucose in their urine.

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The next 3 items refer to the following information:

The table shows the normal composition of blood plasma, of fluid from Bowman's capsule, and of urine (g/100 mL of fluid).

Components	Blood plasma	Fluid from Bowman's capsule	Urine
Urea	0.03	0.03	2.00
Uric acid	0.004	0.004	0.05
Glucose	0.10	0.10	none
Amino acids	0.05	0.05	none
Total minerals	0.72	0.72	1.50
Proteins and fats	8.00	none	none

11d-7 Glucose is not found in the urine because it is

– Co 2 (c) B

A a large molecule.
B reabsorbed before reaching the bladder.
C absorbed in the stomach and small intestine.
D stored in the liver.

11d-8 The urine of a person on a high protein diet would contain

– Co 3 (c) D

A no urea.
B less than 2.00 g of urea per 100 mL.
C 2.00 g of urea per 100 mL.
D more than 2.00 g of urea per 100 mL.

11d-9 Proteins and fats are not found in the urine because

– Co 4 (c) A

A they are large molecules.
B both proteins and fats are reabsorbed before reaching the bladder.
C proteins are denatured in the liver, and fats are absorbed in the small intestine.
D both compounds are stored elsewhere in the body.

11d-10 If proteins responsible for the clotting of blood are found in a person's urine it would indicate a disorder of the

– Ap 2 (c) B

A hypothalamus.
B glomerulus.
C tubule.
D ureter.

11d-11 If amino acids are found in the urine it could indicate a disorder of the

– Ap 3 (c) C

A hypothalamus.
B glomerulus.
C tubule.
D ureter.

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INCORRECT response items

11d-12 Each of the following occurs by diffusion.

10d
Kn
3
(I)
B
*

A movement of water from the soil into root hairs
B movement of glucose from the kidney tubules into the blood capillaries
C movement of oxygen into a red blood cell
D movement of carbon dioxide through stomata

11d-13 The hormone ADH (anti-diuretic hormone) stimulates reabsorption of water into the blood by the kidneys. Mammals suffering from the disease *diabetes insipidus* fail to produce this hormone.

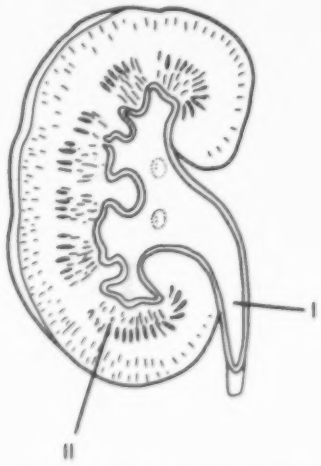
Ap
3
(I)
A
*

These individuals would be expected to

A produce very moist faeces.
B need a high intake of fluids.
C have drier than normal mucous linings of the nose.
D produce large amounts of dilute urine.

11d-14 The following diagram is of a normal mammalian kidney.

An
3
(I)
A



Analysis of the fluid from point I would reveal differences in composition from the fluid in the microscopic tubules at point II.

One would expect

A no protein at point I but a protein concentration similar to blood plasma at point II.
B a urea concentration at point I higher than at point II.
C a glucose level at point II similar to that found in blood but little or no glucose in the fluid at I.
D less water at point I than in the fluid at point II.

11d-15 A *diuretic* is a substance which can be taken by mouth to increase the production of urine.

An
4
(I)
A

Each of the following would be a reasonable expianation of the way such a substance acts.

A increased muscular contraction of the bladder
B decreased reabsorption of fluid from the tubule of the nephron
C increased rate of filtration of fluid at the glomerulus of the nephron
D reabsorption of water from contents of the large intestine

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11d-16 17e Ap 3 (I) D The table below shows the results of a chemical analysis of urine when the *same* person is placed on a high protein diet for one week then placed on a low protein diet for one week.

	High protein diet (after 1 week)		Low protein diet (after 1 week)	
Nitrogen present	g	% nitrogen	g	% nitrogen
Nitrogen as urea	20.45	87.9	2.90	67.5
Nitrogen as ammonia	0.82	3.5	0.17	4.0
Nitrogen in other forms	2.01	8.6	1.23	28.6
Total nitrogen in urine	23.28	–	4.30	–
Total urine	1550 mL		960 mL	

Each of the following conclusions is consistent with the data presented.

A Urea is the main product of protein breakdown.

B The water intake is higher when the person is on the high protein diet than the low protein diet.

C More water is absorbed through the kidney tubules when on the low protein diet than the high protein diet.

D The rate at which the body converts other forms of nitrogen to urea is greater for the low protein diet.

Mammalian Internal Transport and Maintenance

11e—Exchange and transport by blood vascular and lymphatic systems

CORRECT response items

11e-1 – Kn 1 (c) B Which one of the following does **not** depend upon a large surface area for its efficient functioning?

A the alveoli of the lungs
B the chambers of the heart
C the villi of the small intestines
D the gill filaments of fish

11e-2 – Kn 1 (c) C The presence of valves between the chambers of the heart ensures that

A blood is maintained at a constant pressure.
B blood can move directly into the aorta.
C blood flow is restricted to one direction.
D all chambers of the heart can fill with blood simultaneously.

11e-3 – Kn 2 (c) B Which one of the following statements concerning the lymphatic system is correct?

A It is completely separate from the blood circulatory system.
B It collects and returns tissue fluid to the blood circulatory system.
C It consists of transparent vessels and lymph fluid without a cellular content.
D It contains fluids which will circulate only when the body is actively exercising.

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11e-4 The human red blood cell is structurally suited to its function because it

–
Kn
2
(c)
A

A contains haemoglobin which can reversibly form a complex with oxygen.
B is a disc shape to reduce surface area.
C contains enzymes to digest foreign bodies that enter the blood.
D contains a nucleus to ensure a long and active life.

11e-5 Most of the carbon dioxide in the blood is carried in the form of

–
Kn
3
(c)
B

A a haemoglobin compound.
B bicarbonate ions present in the plasma.
C carbon dioxide molecules dissolved in the plasma.
D carbonic acid molecules in the plasma.

11e-6 Proteins normally present in mammalian blood

–
Kn
4
(c)
C
•

A move freely between the plasma and extracellular fluid.
B are reabsorbed from the kidney tubules.
C assist in regulating the water content of blood.
D are absorbed from the small intestine.

11e-7 Mammals have a specialized gas transport system whereas the protozoan, *Paramecium*, is able to exchange carbon dioxide and oxygen directly by diffusion.

–
Co
2
(c)
A

Which one of the following best accounts for this difference?

A The *Paramecium* has a sufficently large surface area in relation to its volume for adequate exchange of gases.
B Gases can diffuse through the membrane of *Paramecium*, but mammalian cell membranes are impermeable to gases.
C Mammalian cells have a smaller surface area in relation to their volume than the *Paramecium*.
D The *Paramecium* has more energy available for transport of oxygen molecules across the membrane.

11e-8 A mammalian red blood cell travelling from the intestine to the lung must pass through

–
Co
3
(c)
A

A the liver and heart.
B the liver only.
C the heart only.
D neither liver nor heart.

11e-9 When blood is lost from a mammalian body, arterial blood pressure falls.

–
Co
4
(c)
D

Which of the following responses would assist in restoring blood pressure?

A decrease in heart rate
B increase in blood flow to skin capillaries
C decrease in lymph flow
D decrease in urine production

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11e-10 The transport of substances in plants differs from that in animals since

–
Co
3
(c)
C

A only plants carry gases in solution.
B plant vascular systems carry mineral salts but animal vessels do not.
C only animal vascular systems carry respiratory pigments.
D animals and plants have different requirements for cellular respiration.

11e-11 Which of the following describes a possible path of a red blood cell through the human body?

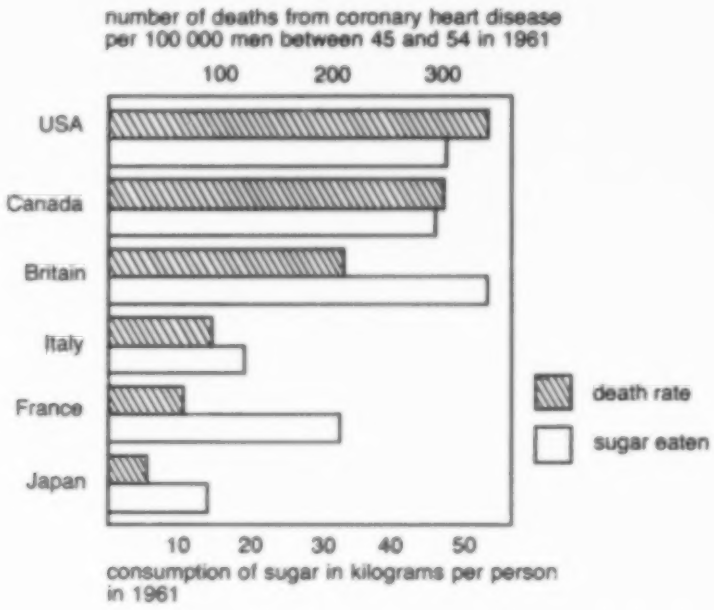
–
Co
4
(c)
B

A heart, kidney, lung, intestine, liver
B heart, kidney, heart, lung, heart, intestine, liver
C heart, lung, heart, kidney, liver, intestine
D heart, lung, kidney, intestine, liver

INCORRECT response items

11e-12
17b
Co
2
(i)
C

The graph represents the results of a study on the relationship between sugar consumption and heart disease.



The following statements are supported by this information.

A The consumption of sugar per person in Canada is similar to that of the USA.
B There is some relationship between sugar comsumption and death rate.
C A French person has a greater chance of dying from coronary heart disease than does an Italian.
D The death rate by coronary heart disease in Japan is approximately one-eighth that of Canada.

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11e-13 The following features assist the functioning of a red blood cell.

– Kn 3 (i) B

A a biconcave disc shape
B a membrane freely permeable to haemoglobin
C a flexible cell membrane allowing the cell to squeeze along thin capillaries
D a weak association between oxygen and haemoglobin

11e-14 When comparing the lymphatic and venous systems in the mammalian body, it can be correctly stated that

– Co 3 (i) C

A apart from a higher concentration of white blood cells lymph is similar in composition to blood plasma.
B fluid movement to the heart in both systems requires the action of muscles and one-way valves.
C lymph is fluid which has come into contact with body cells whereas venous blood is fluid which has not left the blood vessels.
D the lymphatic system carries lymph to large veins near the heart where it mixes with blood.

11e-15 The table shows a comparison of the levels of oxygen, carbon dioxide and nitrogen in blood. It also gives experimentally determined levels for the amount of each gas which can dissolve in the blood under body conditions.

– Ap 4 (i) C

	Oxygen (mL / 100 mL)	Carbon dioxide (mL / 100 mL)	Nitrogen (mL / 100 mL)
Amount present in arterial blood	20.0	50.0	1.70
Amount present in venous blood	14.0	56.0	1.70
Amount which could dissolve in blood under body conditions	0.40	2.96	1.04

The following statements are consistent with the information set out in the table above.

A Most of the oxygen and carbon dioxide carried in the blood is not in the form of dissolved gas molecules.
B Nitrogen is more soluble in blood than oxygen.
C Most of the oxygen in the blood is used up when the blood comes into close contact with the tissue cells.
D Tissue cells absorb oxygen and release an equivalent amount of carbon dioxide.

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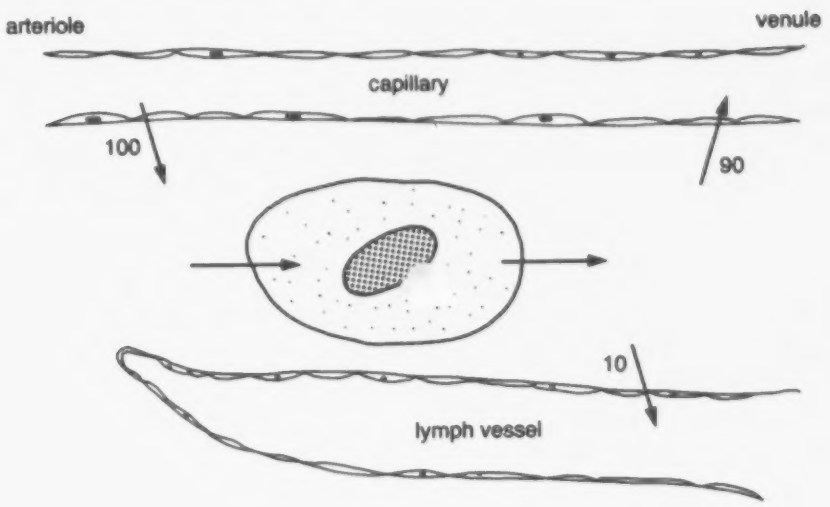
11f—Maintenance of the cellular environment

CORRECT response items

The next 2 items refer to the following diagram:



11f-1 A volume of fluid from the arteriolar end of the capillary, when compared with the same volume of extra-cellular fluid, would always contain more

Co
3
(c)
C

A carbon dioxide.
B water.
C proteins.
D salts.

11f-2 Of 100 molecules of a substance that leave the arteriolar end of the capillary, 90 molecules enter the venous end of the capillary and 10 molecules enter the lymph vessel.

Ap
3
(c)
C

The substance is most likely to be

A oxygen.
B glucose.
C water.
D carbon dioxide.

INCORRECT response items

11f-3 Each of the following organs would help to regulate the water level in the body.

Kn
1
(l)
B

A sweat gland
B heart
C kidney
D large intestine

11f-4 Each of the following processes carried out in the liver is required to regulate the internal environment.

11a
Kn
2
(l)
C

A the breakdown of amino acids to form urea
B the conversion of glucose to glycogen
C the production of red blood cells
D the inactivation of toxic substances and hormones in the bloodstream

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11g—Tissue maintenance and the immune system

CORRECT response items

11g-1 Which one of the following statements about antibodies is correct?

– Kn 3 (c) C

A They combine with antigens to form compounds which protect the body against bacteria or viruses.

B They combine with phagocytes to form cells resistant to invading particles.

C They are produced in response to the stimulus of bacteria and viruses entering the body.

D They are produced by antigens present in the body.

11g-2 An individual has been inoculated with a particular antigen. Three weeks later the inoculation is repeated.

– Co 2 (c) A

One would expect that, after the second inoculation, antibodies specific to the antigen

A are produced more quickly and in greater quantity than after the first.

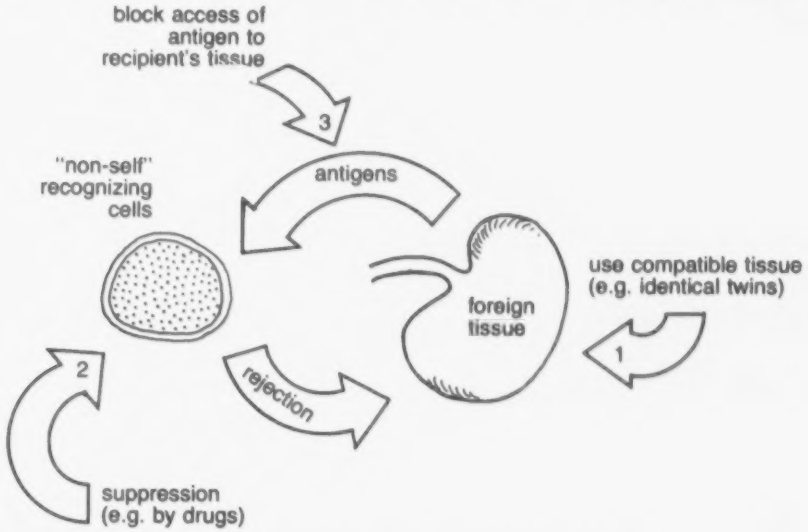
B are produced more quickly but in smaller quantity than after the first.

C are produced more slowly but in greater quantity than after the first.

D are not produced in any quantity as the antibodies from the first are still present in abundance.

The next 4 items refer to the following information:

A major hazard in the transplantation of organs from one human to another has been the rejection of the transplant by the recipient. Transplanted organs, such as hearts and kidneys, contain a wide range of proteins (antigens) which are foreign to the recipient body. For a transplant to be successful, the immune response must be prevented from occurring, otherwise the new organ will be rejected and the recipient will most likely die. The figure below gives three possible ways in which prevention could occur.



Three Possible Ways of Preventing the Immune Response

Notes:

(1) Any hereditary relationship between donor and recipient reduces the number of foreign proteins being implanted.

(2) Certain chemical substances (immuno-suppressants) are capable of blocking the immune response, e.g. a drug (azathioprine), which prevents or slows down cell division of body cells, and a serum (ALG), which attacks the 'non-self' recognizing cells themselves.

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11g-3 Cortisone is a substance which, if taken in suitable amounts, prevents rejection of a transplant by apparently interfering with the action of the 'non-self' recognizing cells.

– Co 3 (c) D

The above information indicates that the effect of cortisone is most like

A a protein.
B azathioprine.
C an antigen.
D ALG.

11g-4 Which one of the following is the best definition of the term 'non-self'?

– Ap 2 (c) C

A an organ transplanted from one human to another
B a protein present in a human other than the one being considered
C a protein which is different in some way from any present in the human under consideration
D a skin graft from one person to another not closely related

11g-5 Indentical twins are good donors and/or recipients for transplants between one another.

– Ap 3 (c) A

This is because

A the 'non-self' recognizing cells do not identify the transplant cells as different.
B the 'non-self' recognizing cells cease to function when a transplant has come from an identical twin.
C identical twins must have the same antibodies circulating in their bloodstreams.
D proteins from identical twins are blocked from reaching the 'non-self' recognizing cells.

11g-6 Consider the problem of a person with a transplant organ who is taking regular doses of an immuno-suppressant.

– Ev 3 (c) C

If the person becomes infected with dangerous disease-producing bacteria, which one of the following courses of action would be most advisable?

A Stop taking the immuno-suppressant until the body's immune response mechanism has cleared up the infection.
B Take an antibacterial drug, **instead** of an immuno-suppressant until the infection has cleared up.
C Take an antibacterial drug **as well as** the immuno-suppressant.
D Take the immuno-suppressant **only**.

11g-7 Three of the statements below are true for both phagocytes and antibodies.

– Kn 3 (c) D

Which one of the statements is **true for antibodies only**?

A They are involved in protecting the body against invading particles.
B They pass through the walls of blood vessels to a site where invading particles have entered the body.
C Many are manufactured in the lymphatic tissue and spread throughout the body.
D They are complex compounds but cannot be regarded as living cells.

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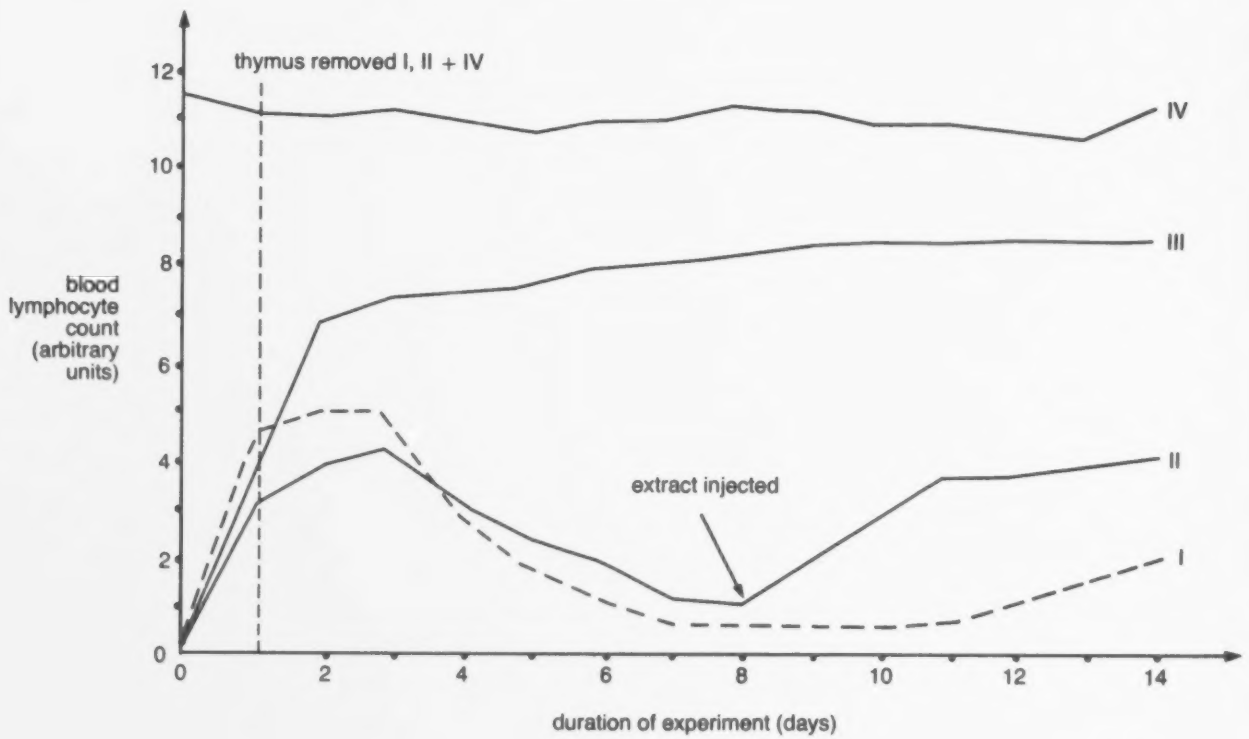
The next 2 items refer to the following information:

As part of an investigation into the role of the thymus gland in the developing immune system of young mice, groups of new-born and mature mice were exposed to the following treatments.

Group no.	Treatment
I	new-born mice; thymus removed within 24 hours of birth.
II	new-born mice; thymus removed within 24 hours of birth; extracts from these glands were injected into the same mice on day eight.
III	new-born mice untreated
IV	mature mice; thymus removed within 24 hours of starting experiment

Counts were made of the number of lymphocytes in blood samples from each group at the start of the experiment, and thereafter at daily intervals for 14 days. The changes in the blood lymphocyte count during the course of the experiment are indicated in the graphs.



11g-8 The following statements seem reasonable in view of the above information.

17e An 4 (I) C

A Chemicals in the thymus glands of young mice stimulate mitosis in white blood cells.

B The rate at which lymphocytes enter and leave the bloodstream in young mice is influenced by the thymus.

C Most of the lymphocytes in the blood of young mice are produced by the thymus within two days of birth.

D Other organs or tissues are also involved in the development of the immune system in mice.

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11g-9 17d
An 3 (I) C

From the results of the experiment and your knowledge of the immune response, it could be predicted that

A the thymus produces a hormone which influences the production of antibodies.

B thymus glands transplanted from mature mice into newly-born mice would be unlikely to survive.

C the level of cellular immunity in young mice reaches a maximum during the first 14 days of life.

D extracts of thymus glands from mature mice would stimulate the production of lymphocytes in young mice.

The next 2 items refer to the following information:

A foetus is able to flourish in its mother's uterus without signs of rejection by the mother's immune system because the tissues of the foetus are separated from the mother's by the placenta. The placenta acts as a sieve; it prevents the passage of blood cells between mother and child, but allows nutrients and oxygen to pass from the mother to the child and wastes to pass from the child to the mother.

Sometimes the placental membrane ruptures and allows fragments of the child's red blood cells to pass into the mother's bloodstream. If the child's red blood cells contain a particular antigen, known as the Rhesus (Rh) antigen, which is not present in the mother's cells, a condition known as *haemolytic disease of the new-born* can develop. Even after the rupture heals, there is continuous destruction of the child's red blood cells leading to jaundice and, in severe cases, the death of the infant.

11g-10
An 4 (I) B

Haemolytic disease of the new-born could occur if

A the blood of the mother does not normally contain Rh antibody.

B Rh antibodies remaining in the child's bloodstream after the rupture heals are able to stimulate further antibody production.

C Rh antigens which pass into the mother's bloodstream can be destroyed by the Rh antibody.

D phagocytosis is stimulated by red blood cells damaged by the Rh antibody.

11g-11
Ap 4 (I) D

Assume that a mother is pregnant with a child who has the Rh antigen, and that the mother lacks this antigen.

Possible ways to minimize the risk of *haemolytic disease of the new-born* would be to

A give the mother an injection of human antibodies against the Rh antigen shortly after conception.

B treat the mother with an anti-Rhesus blood protein to block the Rh antigen in the foetal cells.

C perform a blood transfusion and replace the foetal blood with blood not containing the Rh antigen.

D inject the mother with the Rh antigen within the first few weeks of pregnancy.

11g-12
Kn 2 (I) D

The body is able to defend itself against invading microorganisms because

A lymphocytes are able to attract and stimulate phagocytes.

B antibodies continue to exist in the blood once the antigens have been destroyed.

C plasma cells produce antibodies in response to the arrival of an antigen.

D one type of antibody molecule is able to combine with a variety of antigens.

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11g-13 – Kn 1 (I) C One important response to an infection is the antigen–antibody reactions that occur in the body.

The following are features of this reaction in the body.

A The antibody is specific for a particular antigen.

B Antibodies are found in blood plasma and are protein in nature.

C The range of antibodies possessed by an individual were inherited and have been present since birth.

D Antibodies are associated with phagocytes in protecting the body.

11g-14 – Co 3 (I) B Success in human transplants depends on the fact that people differ in the structure of the transplantation antigens which make up the surface layer of tissue cells.

Possible ways to minimize the danger of rejection of tissue transplants by the recipient's immune system could include

A preventing lymphocytes in the recipient from multiplying by using certain drugs.

B transfusion to the recipient of the donor's blood serum containing antibodies.

C ensuring that the transplantation antigens of recipient and donor differ as little as possible.

D treating the recipient beforehand with antigens of the graft.

11g-15 – Ap 3 (I) B Certain viruses are known to be able to induce cancer in experimental animals such as mice. The cells produced as a result of this infection are typical of other types of malignant cells in that the rate at which they divide is greater than in normal cells. Recently it has also been recognized that the surface antigens of malignant cells are structurally different to the antigens on the tissue cells from which they originated.

Some of the more effective ways of treating virally-induced cancers in laboratory mice could include the use of

A drugs to stimulate the production of lymphocytes involved in cellular immunity.

B chemicals to block the surface of the antigens on the cancer cells.

C specific anti-viral antibodies to destroy the virus particles in the bloodstream.

D mouse interferon to prevent the virus from multiplying once it is inside a host cell.

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Animals and the Environment

11h—Sense organs, body surfaces, musculo-skeletal systems

CORRECT response items

11h-1 If a muscle moves a bone then closer examination will shown that this muscle

–
Kn
1
(c)
C

A is attached to that bone and pushes it.
B is attached to the bone at one end and is free at the other end.
C is attached to that bone and to another by tendons.
D is attached to the bone by a ligament.

11h-2 Earthworms tend to move away from regions of dry soil.

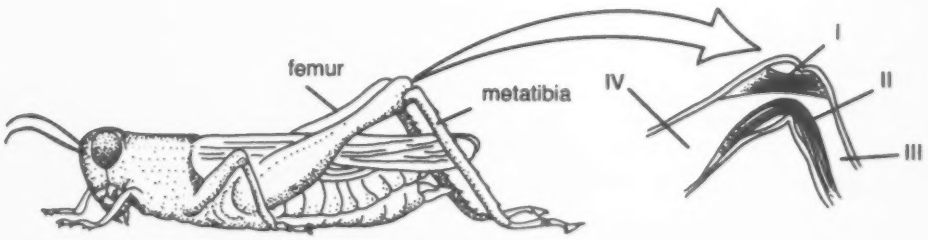
–
Co
1
(c)
B
*

This response is probably initiated as a result of

A the worms' heat receptors detecting the warmer dry soil.
B the activities of cells which are sensitive to the amount of water present.
C the reduced exchange of gases in the dry soil.
D the small quantity of food which is present in dry soil.

11h-3 The following diagram shows how muscles are positioned within the leg of a grasshopper.

–
Ap
2
(c)
C
*



Which of the following statements is true?

A If I and II contract together, the leg would straighten.
B Relaxing I and II maintains the relative positions of III and IV.
C Contraction of II would raise III.
D Contraction of I would lower IV.

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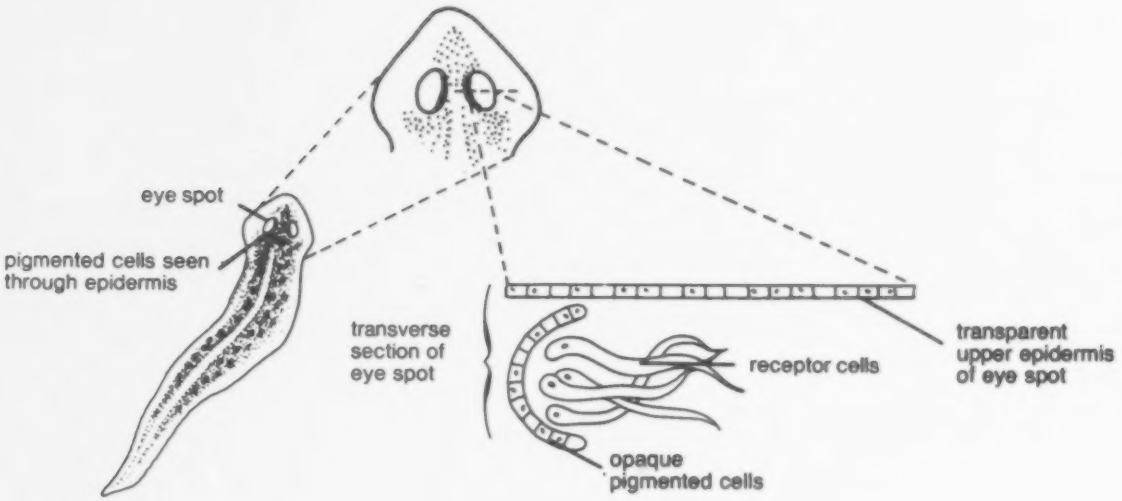
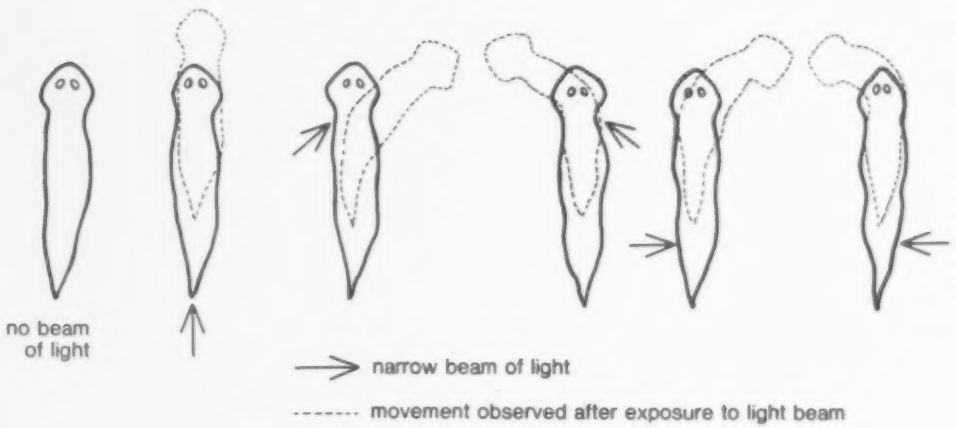
The next 2 items refer to the following information:

Planaria are small flatworms commonly found in uncontaminated rivers and streams. A noticeable feature of this animal is its two, relatively large, anterior eye spots. The receptor cells of each 'eye' lie beneath a layer of transparent epidermal cells, and are partly shaded by a cup-like arrangement of opaque pigmented cells.



A demonstration was carried out on a planarian in the laboratory, under normal light conditions, by shining a narrow beam of brighter light onto different regions of the animal. The observations were recorded as follows.



11h-4 From the above information it would be reasonable to state that a planarian

- **A** can detect light from all directions.
- **B** retreats from the presence of light.
- **C** is able to respond to differences in light intensity.
- **D** is unable to detect a light beam from the front.

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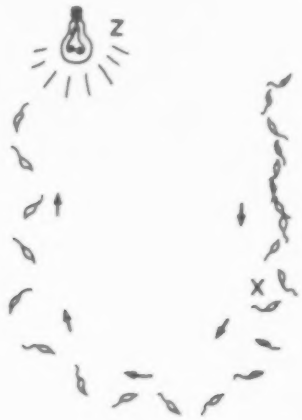
11h-5 In their natural surroundings, you would expect that planaria

–
Ap
2
(c)
A
*

A inhabit the shadier parts of rivers and streams.
B are capable of judging distance.
C are active only at night.
D rely on sight for feeding.

11h-6 The path of a motile alga is shown by arrows in the diagram below. When the alga reached point X a light at Z was turned on.

–
Co
2
(c)
A
*



Of the following, the best explanation for the alga's change in direction is that

A it has a light-sensitive structure which determines its orientation to light.
B it swam towards the warmer water as it is more active in warmer water.
C the light stimulates rapid movement towards it.
D it swam towards the light in order to carry out photosynthesis more efficiently.

INCORRECT response items

11h-7 There are many receptors located within and on the surface of mammals. These enable the animal to 12a detect changes and adjust accordingly. Internal receptors play an important role in homeostasis.

Kn
2
(i)
C

The following changes would be detected by internal receptors.

A an increase in blood pressure
B a fall in blood glucose concentration
C an increase in brain activity
D a fall in blood carbon dioxide level

11h An exoskeleton is important to many animals, as it

–
Kn
2
(i)
C

A helps reduce water loss.
B provides an attachment for muscles.
C allows unrestricted growth.
D absorbs solar radiation.

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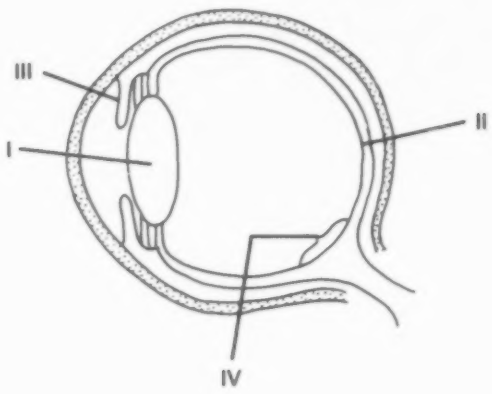
11h-8 The following is a diagram of the human eye.

–
Kn
3
(I)
D

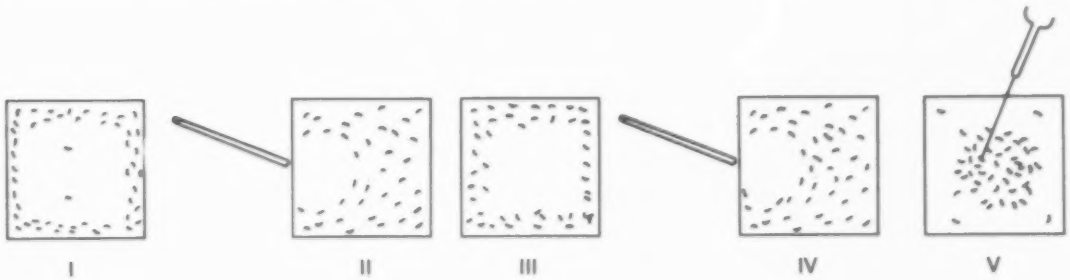


The numbered structures have functions as indicated

	Structure	*Function*
A	I	condensing and focusing incoming light
B	II	forming an inverted image
C	III	regulating the amount of light entering the eye
D	IV	detecting light with receptor cells

11h-9 The diagrams show how protozoa distribute themselves in a shallow dish of pond water after appli-
17g cation of each of the following treatments.
Co
1
(I)
D

Dish no.	Treatment	
I	kept in darkness	–
II	kept in darkness	side of dish gently tapped with glass rod
III	kept in light	–
IV	kept in light	side of dish gently tapped with glass rod
V	kept in light	dilute acid added through a syringe



From the demonstration it is reasonable to conclude that protozoa are able to detect

A vibration.
B the walls of the container.
C molecules in solution.
D light.

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11h-10 Chemoreceptors are important to many organisms because they can

Co
3
(I)
D

A assist in bringing the two sexes together for mating.
B permit recognition of territorial boundaries.
C detect changing levels of acid in the digestive tract.
D relay chemical messages to the brain.

11h-11 The polar bear is a mammal that exists in a very cold climate yet maintains a constant internal temperature.

Co
3
(I)
D

Features assisting this temperature maintenance include

A a thick coat of hair.
B a small surface area to volume ratio.
C a high metabolic rate.
D a white coat that reflects solar radiation.

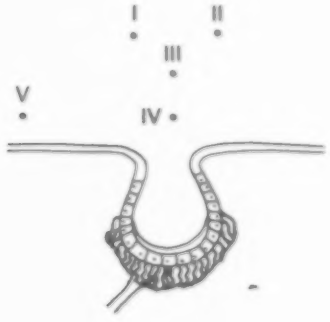
11h-12 The epidermal layer of the human skin has

Co
3
(I)
C

A both living and dead cells present, but at different depths.
B mitotic divisions so that the correct thickness of epidermis is maintained.
C blood capillaries that move into this layer when a person is very hot.
D varying thickness depending on the location on the body surface.

11h-13 The diagram is of a longitudinal section through the eye of a *Nautilus*, a shell-bearing marine mollusc. The numbers indicate where an object was placed at various positions near the eye.

Ap
3
(I)
B



From the diagram and your knowledge of the mammalian eye, you would expect the nautilus eye to

A be unable to locate V.
B form a clear image of an object moving from III to IV.
C detect movement from I to II.
D form an image of the overall shape of an object at III.

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11h-14 – Kn 3 (I) B

The skin is a vital organ in all animals.

In mammals the skin functions **mainly** to

A help control body temperature.
B support underlying organs and tissues.
C detect changes in the external environment.
D assist in the removal of waste products.

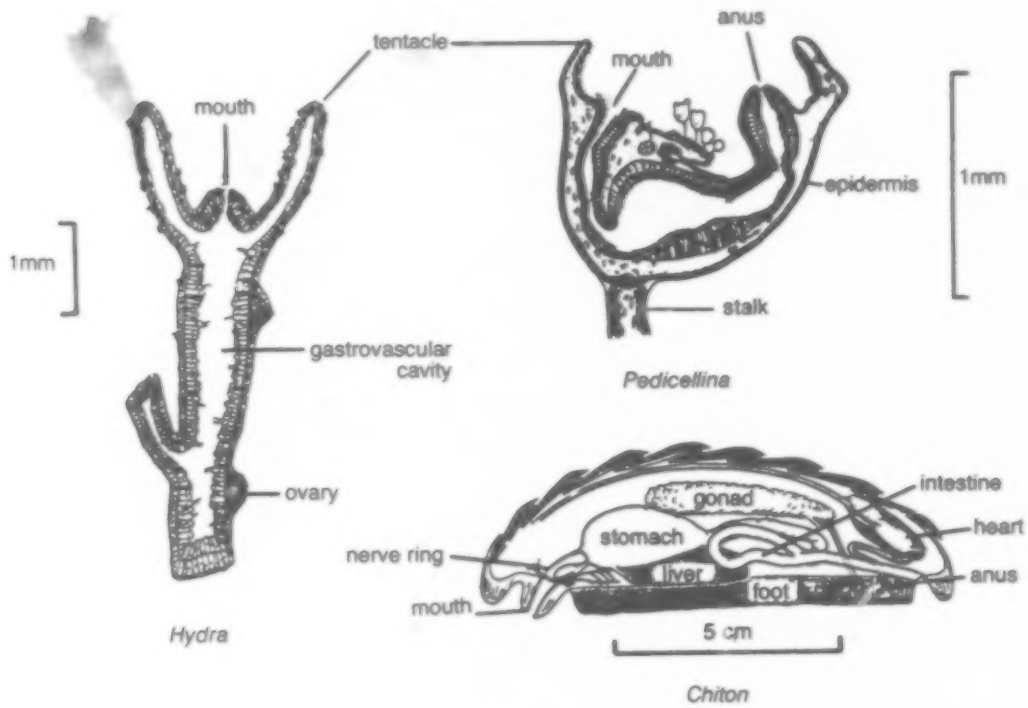
11i—Structural diversity, adaptation, efficiency and inheritance

CORRECT response items

11i-1 – Ap 2 (c) A *

In the digestive tracts of multicellular organisms there may be specialized sections which allow the sequential digestion and absorption of food.

Consider the following diagrams of the organisms *Hydra*, *Pedicellina* and *Chiton*.



This type of specialization is present in

A *Chiton* only.
B all three.
C *Pedicellina* and *Chiton* but not *Hydra*.
D *Pedicellina* and *Hydra* only.

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The next 2 items refer to the following information:

Three new species of animals fit into our existing classification system as shown.

	Species		
	I	II	III
Habitat	terrestrial	marine	terrestrial
Embryo develops in	water	mother	egg
Mates	in water	in water	on land
Skeleton is	internal	internal	internal
Epidermis covered with	slime or mucus	hair	scales

11i-2 – Co 1 (c) B •

Internal fertilization probably occurs in species

A II and III.
B I and III.
C II only.
D I only.

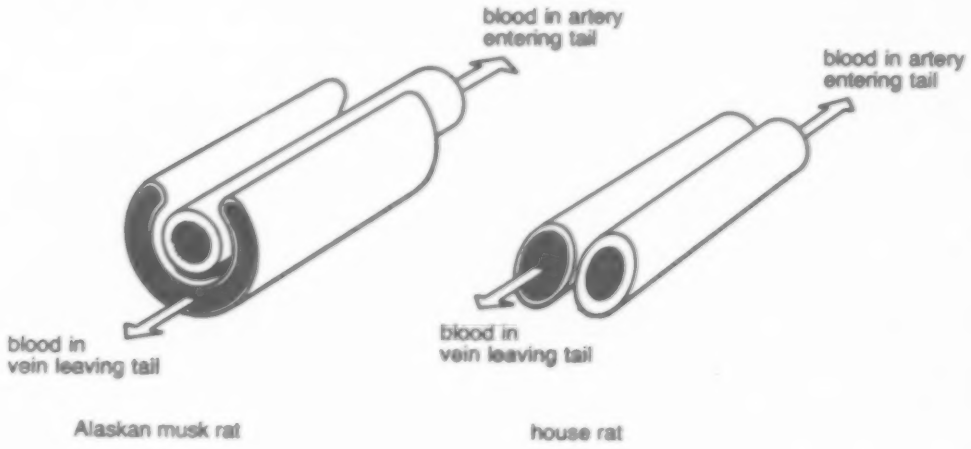
11i-3 – Ap 2 (c) B •

Which of the following would be the most likely sequence based on number of eggs released at one time (least to most)?

A I, III, II
B II, III, I
C II, I, III
D III, II, I

11i-4 – Ap 3 (c) D •

The diagrams show the arrangement of blood vessels in an Alaskan musk-rat tail and in the tail of the house rat. The musk-rat spends much of its time in water where the temperature is about 2 °C.


blood in artery entering tail
blood in vein leaving tail
Alaskan musk rat
blood in artery entering tail
blood in vein leaving tail
house rat

The main advantage to the musk-rat of the arrangement of vessels in its tail is that

A cold blood does not enter the heart.
B cell enzymes are not inactivated by low external temperatures.
C less oxygen is required by cells in the tail.
D less heat is lost to the surrounding water.

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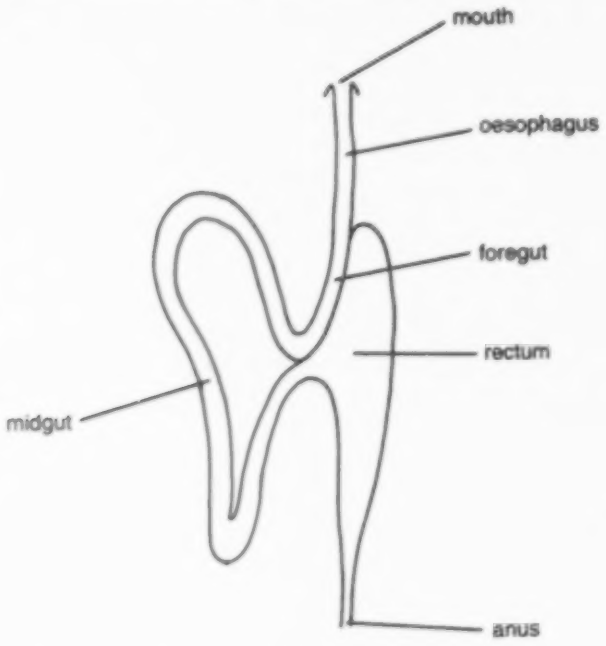
11i-5 – An 5 (c) A

In insects that suck the sap of plants, but not in other insects, the walls of the foregut and the rectum are in very close contact as shown in the simplified diagram below.



Most of the digestive enzymes are producted by the midgut.

Which of the following is the most likely function of the close association between the rectum and the foregut?

A secretion of water to the rectum
B reabsorption of undigested food from the rectum
C transfer of cellulose-digesting bacteria from the rectum to the foregut
D transfer of digestive enzymes from the rectum to the foregut

INCORRECT response items

11i-6 11h An 4 (i) D

The nose is an important mechanism for conserving water in the camel. The camel's nostrils are a maze of scroll-like passages covered with a layer of moisture-absorbing mucus. This mucous lining is on top of a thin layer of epithelial cells that are richly supplied with blood vessels. The surface of the scrolls acts as a heat and moisture exchange system. At night the scrolls are cooled as the cold desert air enters the nose. During this process the air is warmed and humidified and arrives at the lungs at body temperature (35 °C) and is saturated. On the way out, the air from the lungs loses its heat to the scrolls. Water is condensed from the air and trapped by the mucous lining.

On the basis of the above information, it would be reasonable to expect that

A the camel conserves more water at night than during the day.
B the increased surface area of the nasal passages helps to minimize water loss in the camel.
C blood vessels in the nasal scrolls release body heat.
D there is no overall water loss by evaporation from the nasal passages.

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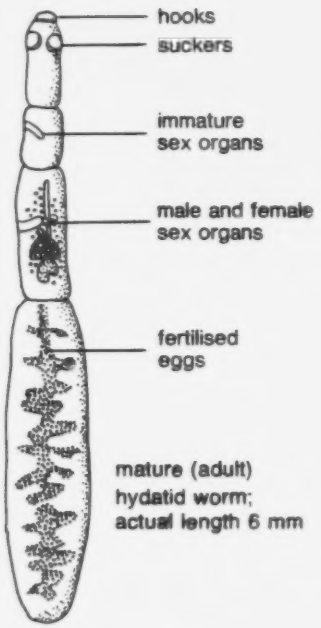
The next 2 items refer to the following information:

The hydatid tapeworm *Echinoccus granulosis* is a parasite of a number of animals, especially sheep and farm dogs. Hydatid disease in man often causes serious illness and death.

E. granulosis has a typical tapeworm life cycle in that it develops in stages involving two host animals. Thus it exists in two different forms, one in each host:

— the mature or adult hydatid worm inhabiting the small intestine of its host (e.g. dog);
— the immature stage which is a cyst (thick-walled, fluid-filled structure) embedded in the body organs of its host (e.g. man and sheep).



11i-7 For the adult worm it is reasonable to suggest that

– Ap 2 (i) D

A the hooks and suckers secure it to the wall of the small intestine.
B its outside surface cannot be digested by amylases, lipases or proteases.
C the presence of both male and female sex organs would be a common feature in an organism of this environment.
D proteins, fatty acids and simple sugars are absorbed through the cuticle.

11i-8 In man and sheep, infection enters through the mouth when eggs are swallowed. When the embryo hatches from the egg it moves through the stomach wall into the bloodstream, and is thus carried to organs such as the liver or lungs. There it develops into a cyst.

– Ap 3 (i) B

The following would assist the survival of the parasite.

A The egg may be enclosed in a case susceptible to digestion by stomach secretions.
B The embryo may lodge in the heart of the host, causing heart failure.
C Most sheep survive hydatid cyst infection and no noticeable symptoms of infection are seen.
D The adult worms will survive for as long as two years in infected dogs.

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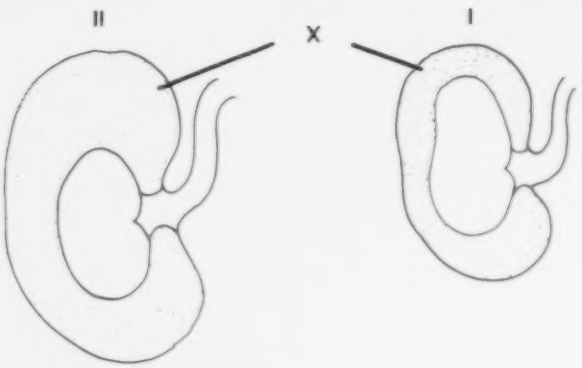
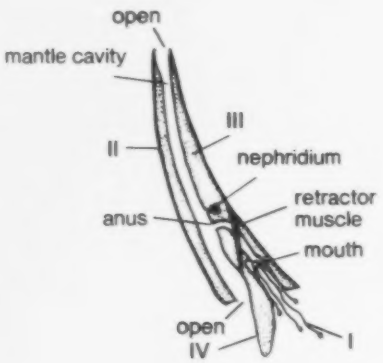
11i-9 11a Ap 3 (i) C The diagram shows transverse sections of the kidney of two members of the same species of terrestrial mammal, one adapted to a desert environment, the other to a temperate environment.

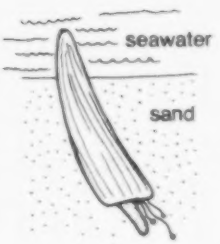


From the diagram, it is reasonable to conclude that

A kidney I is able to produce a more concentrated urine than kidney II.
B kidney I represents the kidney of the mammal from the desert environment.
C kidney I would excrete more urea than kidney II.
D the process of filtration occurs in tissue X in both kidneys I and II.

11i-10 – Ap 3 (i) B The tooth shell is a marine mollusc that lives partly buried in the sand or mud down to depths as great as 5000 metres below sea level. The tooth-like shell surrounding the body is open at both ends. The organism has an internal excretory organ (nephridium) and anus but has no gills or heart. It feeds on organisms buried in the sand. The mantle (III) is a fleshy membranous structure from which the shell is secreted.





It is reasonable to expect the main function of each of the structures numbered would be as follows.

	Structure	*Function*
A	I	locating and capturing food
B	II	resisting water pressure
C	III	gaseous exchange
D	IV	pulling animal down into sand or mud

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The next 2 items refer to the following information:

The marine bivalve mollusc *Solemya parkinsonii* occurs in the shallower coastal waters of the Northern Hemisphere where it is commonly found burrowing in the mud or sand of the sea-bed. A most unusual feature of the mollusc is that it does not have an alimentary tract. It obtains its food, as it does its oxygen, by absorption through the surface of its mantle cavity—a skin-lined hollow inside the shell of the animal through which sea water can freely pass. The mollusc has a close association with heterotrophic bacteria which live either within the mantle cavity or within the molluesc's burrow. Both partners benefit from this type of relationship which is often referred to as *symbiosis* or *mutualism*. (*Biology in Action*, 1982)

11i-11 – Ap 4 (i) D

It is reasonable to suggest that *S. parkinsonii*

A excretes carbon dioxide through its mantle cavity.
B has structures in its mantle cavity to maximize surface area.
C probably occurs in a nutrient-rich environment.
D has no transport system.

11i-12 – Ap 3 (i) D

It is likely that the relationship between the bacteria and the mollusc is important because the bacteria

A remove or destroy toxic wastes produced by the mollusc.
B rely on the same food source as the mollusc.
C digest the larger food particles which can then be absorbed by the mollusc.
D are a nutrient source for the mollusc.

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12 INTEGRATION AND REGULATION IN MULTICELLULAR ORGANISMS

Integration and Control

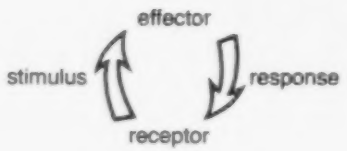
12a—Integration and regulation of body functions, response to change

CORRECT response items

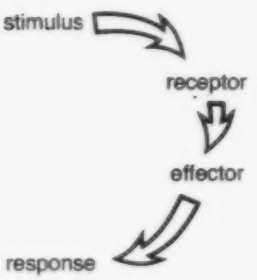
12a-1 Which of the diagrams below most closely resembles a stimulus–response model?

17e
Kn
1
(c)
C

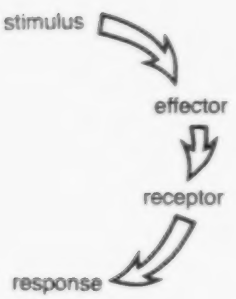
A



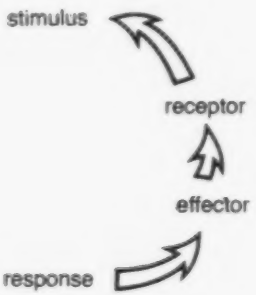
C



B



D



12a-2 By experiment, it was found that the heat loss per unit weight of a small mammal was greater than that of a large mammal, although their body temperatures remained constant.

–
Co
2
(c)
C

Which one of the following conclusions can be drawn from this result?

A Small mammals are more active than large mammals.
B Large mammals are better adapted to their physical environment than small mammals.
C Small mammals have a higher metabolic rate than large mammals.
D Large mammals have a greater surface area than small mammals.

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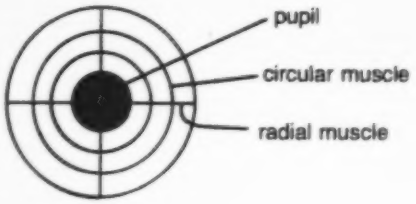
12a-3 **The muscles that operate the iris of the eye—to contract and dilate the pupil—are an arrangement of radial and circular muscles as shown in the diagram.**

– Ap 3 (c) C *



Which of the following indicates the way in which the muscles of the iris operate in bright sunlight?

	Circular muscles	*Radial muscles*
A	contract	contract
B	relax	relax
C	contract	relax
D	relax	contract

12a-4 – Ap 4 (c) B

Mammals are considered by many biologists to be a highly successful class of animals. One special adaptation is to maintain a constant core body temperature. Although external body temperatures may vary greatly, core temperatures vary little. This can be seen in husky dogs where even in extremely cold weather, the feet of the dogs may be only 8 °C.

Which of the following is **least** likely to account for the low foot temperature?

A blood vessel constriction conserving heat

B the distance of the foot from the core of the body

C conduction of heat to the cold ground

D a greater surface area to volume ratio in the foot than in the body trunk.

INCORRECT response items

12a-5 11h An 4 (i) A

When referring to the surface relationships in animal design, an eminent animal physiologist once stated:

> If a steer is designed with the metabolic rate of a mouse, to dissipate heat at the rate it is produced, its surface temperature would have to be well above boiling point. Conversely if a mouse is designed with the weight-related metabolic rate of a steer, to keep it warm it would need to have as surface insulation a fur at least 20 centimetres thick.

Using knowledge of cellular respiration and surface area to volume relationships to help interpret the above information, it would be correct to state that

A a steer has a higher weight-related metabolic rate than a mouse.

B the surface area of a mouse is less than the surface area of a steer.

C a mouse is physically more active than a steer.

D a thinner hair layer in the steer is partly compensated for by a lower surface area to volume ratio.

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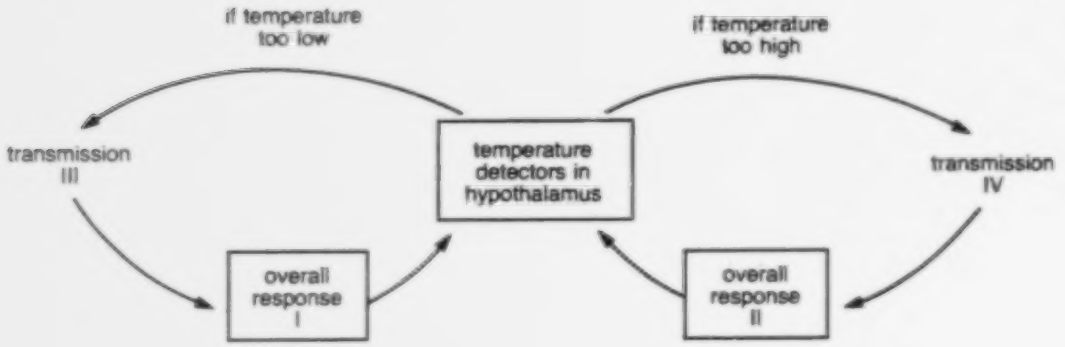
The next 2 items refer to the following information:

In mammals the hypothalamus contains accurate temperature sensors. These initiate a response which occurs via a series of steps.

If the temperature is low the hypothalamus produces a secretion which acts on the anterior pituitary. The anterior pituitary secretes a compound which stimulates the thyroid gland to secrete thyroxin which increases the metabolic rate.

A control mechanism in the regulation of body temperature can be represented as follows:



12a-6 On the basis of this information it would be reasonable to conclude that

An 2 (I) B

A response 'I' would include increased heat production at the cellular level.
B response 'II' would include increased oxygen consumption by body tissues.
C transmission 'III' would involve more than one hormone.
D transmission 'IV' would involve a reduced production of thyroid stimulating hormone by the anterior pituitary gland.

12a-7 The animal would be able to respond to cold after each of the following procedures was carried out.

An 2 (I) D

A lowering the temperature of the hypothalamus
B transplanting the thyroid gland to another part of the body provided connections to the bloodstream were maintained
C injecting an extract of posterior pituitary gland from another animal of the same species
D blocking the blood supply and nerve connections between the hypothalamus and the pituitary

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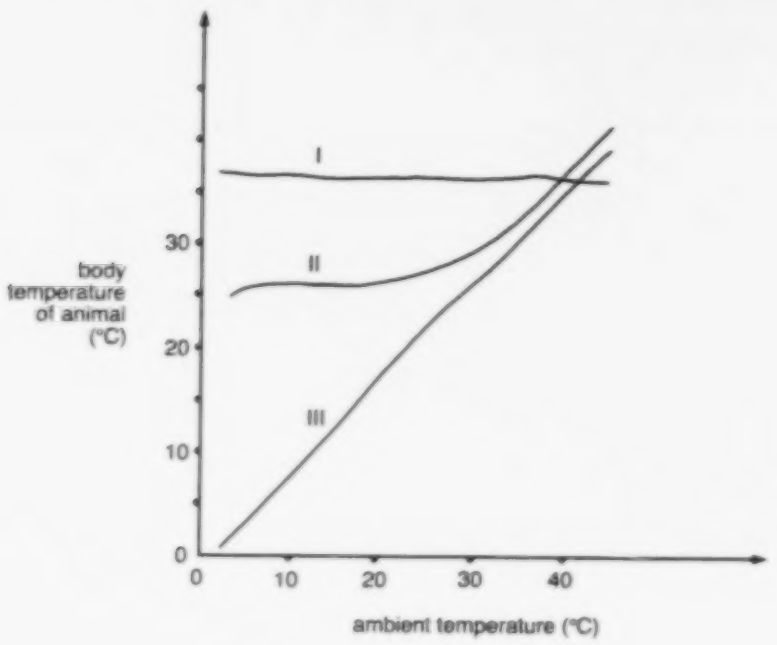
12a-8-Ap5(I)B The graph shows the results of an experiment in which the internal temperatures of three different types of animals were monitored as the ambient (environmental) temperature changed.



Using the graph and your knowledge of temperature regulation it is reasonable to suggest that

A organism I could be a bird.
B organism II might pant or sweat (or both) as the ambient temperature rises above 30 °C.
C at ambient temperatures between 5 °C and 30 °C, organism II is homoiothermic.
D as the ambient temperature increases from 10 °C to 30 °C organism III will become more active.

12a-9-Ap3(I)D* A kangaroo can maintain a constant body temperature even on days when the air temperature exceeds its core temperature.

This can be achieved by

A decreasing activity and thus decreasing metabolic rate.
B licking the fur of forelimbs and chest to increase cooling by evaporation.
C sheltering in the shade of trees to reduce heat uptake by conduction and radiation.
D dilation of blood vessels of the skin to increase radiation of heat from the body.

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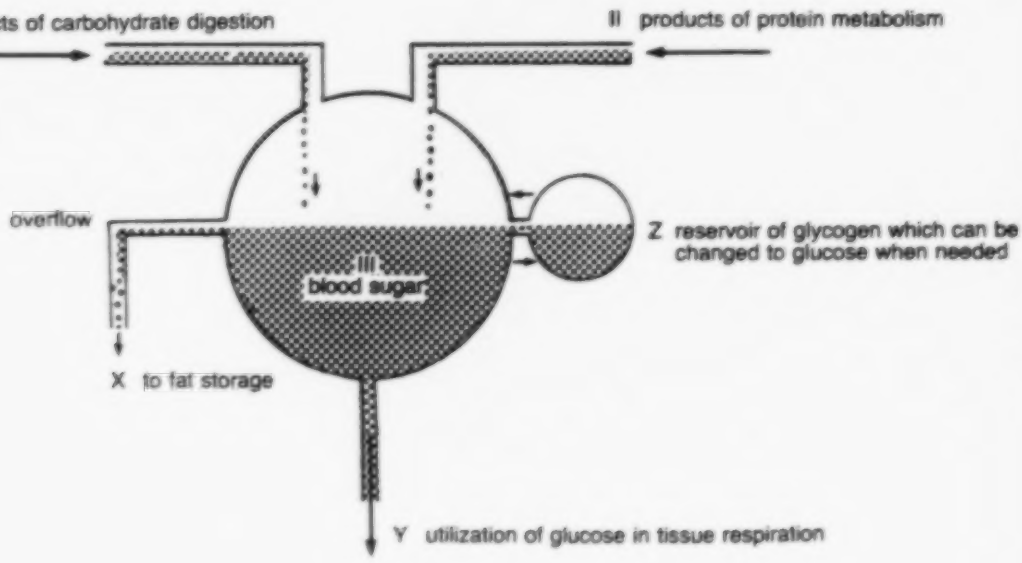
The next 2 items refer to the following information:

The diagram represents a model to explain the losses and gains of blood sugar in the mammalian circulatory system.


I products of carbohydrate digestion
II products of protein metabolism
overflow
Z reservoir of glycogen which can be changed to glucose when needed
III
blood sugar
X to fat storage
Y utilization of glucose in tissue respiration

12a-10 11b Ap 4 (I) B

The following statements apply to the model.

A Input through I would be in the form of simple sugars from the gut.
B Input through II would be in the form of amino acids from the liver.
C The volume of glycogen in the reservoir Z would be regulated by hormones.
D The amount of blood sugar in III would remain relatively constant.

12a-11 11b Ap 2 (I) D

According to the model, the following changes are likely to occur after a large meal of fish and chips.

A increased input of products of starch digestion through I
B increased input of products of protein digestion through II
C conversion of excess glucose to glycogen in reservoir Z
D increased output of glucose through Y for utilization in tissue respiration

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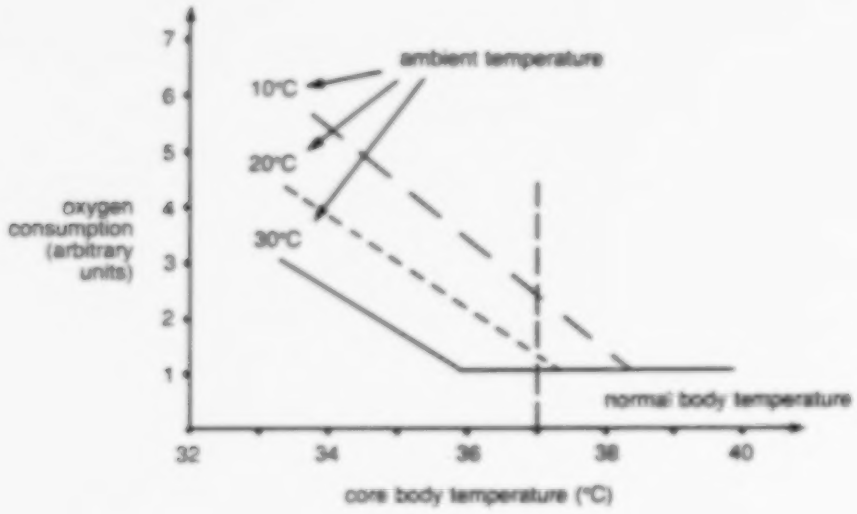
12a-12 – An 4 (I) C The way in which the oxygen consumption of the kangaroo rat varies with changes in core body temperature was measured under 3 different conditions of ambient (air) temperature. The results are shown below.



The graphs indicate that

A if the body temperature decreases there is a body temperature below which metabolic rate increases.

B the threshold temperature for the metabolic heat response rises as the ambient temperature declines.

C a fall in body core temperature is required to stimulate increased metabolic heat production.

D a thermostatic mechanism is involved in compensatory responses.

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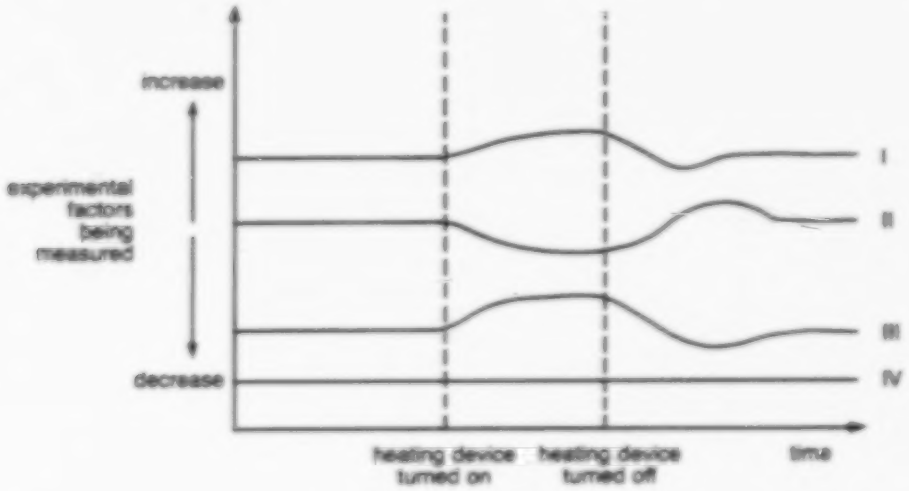
12a-13 – An 4 (i) C •

An experiment was performed to evaluate factors involved in the regulation of body temperature in endotherms. A mammal of normal core body temperature (38 °C) was anaesthetised, and a heating device inserted into the hypothalamus. The animal was allowed to recover and then placed in an environment at 10 °C. The heating device was then turned on and off as shown.



It is reasonable to postulate that

A curve II represents the metabolic rate of the animal during the experiment.
B curve I represents the heat loss by radiation from the skin.
C curve IV represents the core body temperature of the animal throughout the experiment.
D curve III represents the rate of sweating during the experiment.

12b—Nervous systems and hormones

CORRECT response items

12b-1 – Kn 2 (c) A

When a response alters a stimulus, it is called a

A feedback system.
B reflex arc.
C conditioned reflex.
D behavioural response.

12b-2 – Co 1 (c) D •

A person is given a local anaesthetic which completely blocks the sensory nerves in the foot. A blindfold is applied, and the skin covering the foot is sharply pinched with a pair of forceps.

It would be expected that the person would

A feel the stimulus but be unable to respond to it.
B feel the stimulus and jerk the foot away.
C not feel the stimulus but reflex action would move the foot.
D be unaware of the stimulus and would not move the foot.

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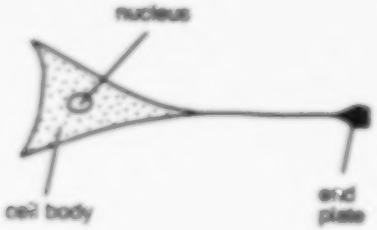
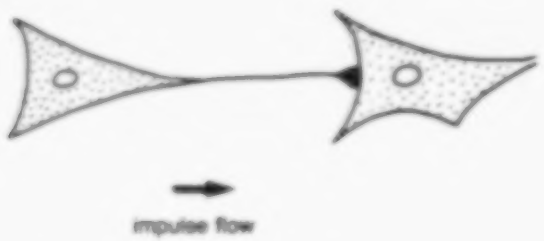
12b-3 The diagram illustrates a typical nerve cell.

–
Kn
3
(c)
C

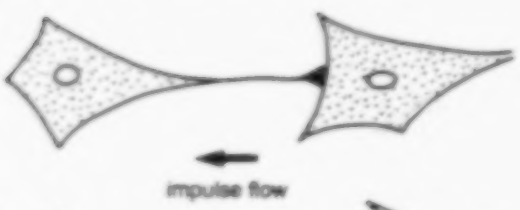


Which of the following diagrams depicts most accurately the pathway of an electrical impulse along two consecutive nerves?

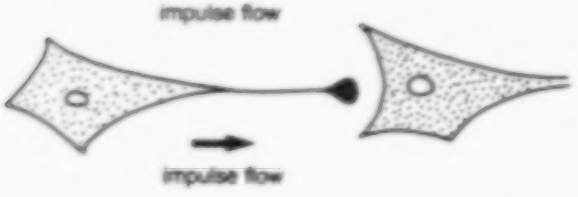
A



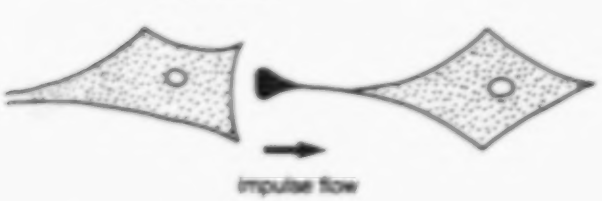
B



C



D



12b-4 Hagfish which have had the spinal cord severed at the anterior end are inactive for long periods of time but when they are touched on the body they swim normally.

–
Ap
2
(c)
B

This movement is therefore **not** likely to

A be a reflex action.
B depend on the brain.
C result from stimulation of sense organs.
D be an automatic response to a stimulus.

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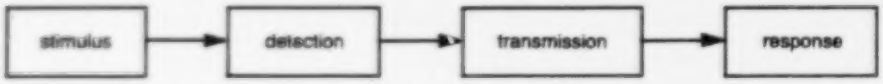
The next 2 items refer to the following information:

A model of the processes by which an organism responds to a stimulus is represented below.



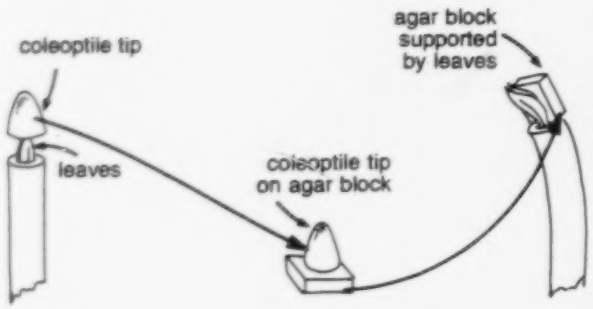
Use the following key to answer the next 2 items.

Key:
- **A** stimulus
- **B** detection
- **C** transmission
- **D** response

12b-5 Which process best describes the elongation of plant cells during phototropic growth?
–
Co
2
(c)
D

12b-6 Which process best describes what takes place on the retina of the eye?
–
Co
3
(c)
B

12b-7 Several coleoptile tips were placed on an agar block for a short time. A piece of this agar, when placed
17d on a coleoptile from which the tip had been removed, resulted in a curvature in the growing coleoptile
Co similar to that seen in a phototropic response.
3
(c)
A



This experiment is designed in such a way that it would test

- **A** if a substance is transmitted from the tip to the coleoptile via the agar.
- **B** if the difference in growth results from the removal of the coleoptile tip.
- **C** if there is a reversal of phototropic growth when the coleoptile tip is removed.
- **D** the effect of agar on plant phototropism.

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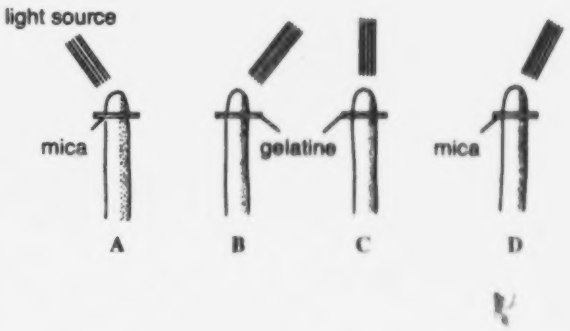
12b-8 – Co 3 (c) B In an investigation, the tips of a number of coleoptiles were removed. The decapitated coleoptiles were divided into two groups and small mica sheets were placed on one group and similar sized gelatine sheets on the other group. The coleoptile tips were then replaced. The mica and gelatine-treated coleoptiles were again divided into two groups and the four resulting groups exposed to a beam of light from one particular direction as shown in the diagram.



All the coleoptiles of one group grew to assume the shape shown below.

Which treatment, A, B, C, or D, does this group represent?

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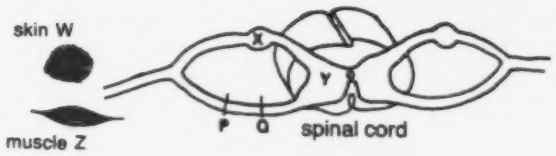
The next 2 items refer to the following diagram:



12b-9 Consider a motor neurone linking the receptors in the skin to the muscles.

– Kn 4 (c) C *

The cell body of this motor neurone is located at region

A W.
B X.
C Y.
D Z.

12b-10 The nerve was severed at points P and Q.

– Co 4 (c) D *

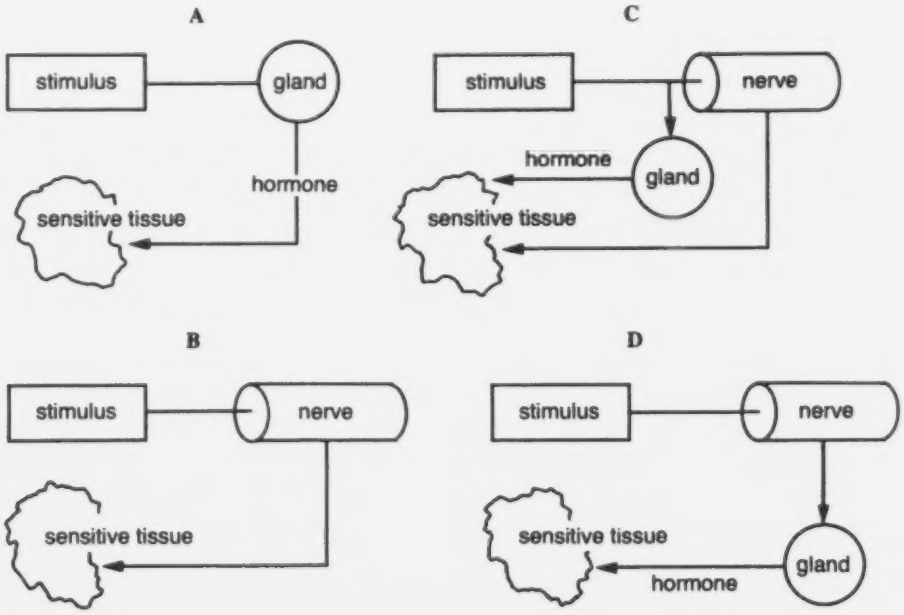
If the cut end Q, which is still attached to the spinal cord, is stimulated this would result in

A responses in the muscle only.
B responses elsewhere in the body but not in the muscle.
C responses in the muscle and elsewhere in the body.
D no responses in the muscle or elsewhere in the body.

12b-11 12h Co 3 (c) D

The toad *Xenopus* is observed to change the depth of colour of its skin with the darkness of its background. Biologists found that cutting the toad's nerve supply to the sensitive tissue in the skin did not affect the mechanism, but cutting the nerve from the eye to the brain did prevent colour change occurring. After removing the pituitary gland (which secretes many hormones) a dark toad became light but when it was injected with pituitary gland extract it darkened again.

Which one of the following models fits the above experimental data?



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INCORRECT response items

12b-12 The following are examples of endocrine organs.

–
Kn
1
(I)
B

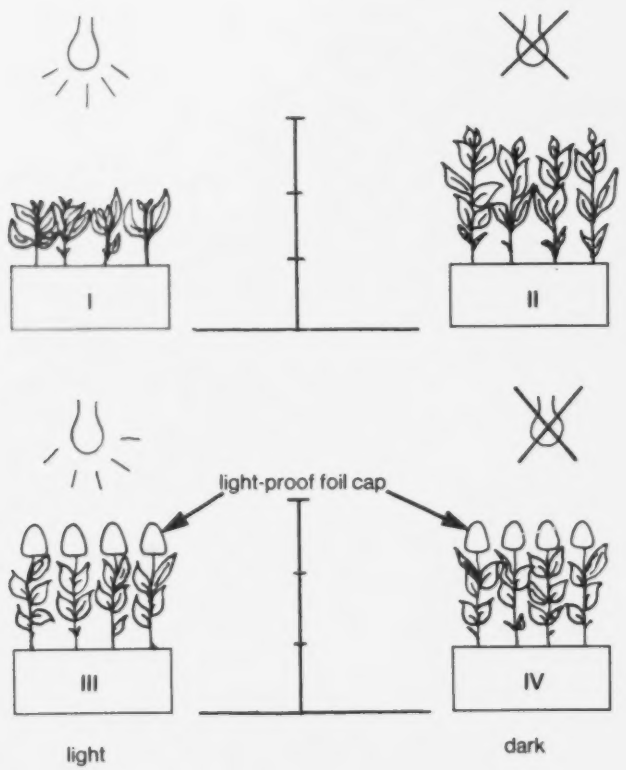
A adrenal gland
B sweat gland
C thyroid gland
D pituitary gland

12b-13
12d
Ap
2
(I)
D

An experiment was carried out to investigate the phototropic response in pea seedlings. Four equivalent groups of day-old pea seedlings were grown for a further 14 days under different conditions as follows:

Group I:	grown in light
Group II:	grown in dark
Group III:	grown in light; light-proof foil cap on each coleoptile
Group IV:	grown in dark; light-proof foil cap on each coleoptile

After 14 days the seedlings appeared as shown in the diagram.



From the experiment, and your knowledge of auxins, it would be reasonable to state that

A auxin is produced in the coleoptile tip.
B light deactivates auxin produced in the coleoptile tip.
C the coleoptile tip detects the light stimulus.
D light promotes cell elongation.

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The next 2 items refer to the following information:

Cockroaches avoid the sudden lunge of a predator, such as a toad, by turning and fleeing from the direction of the attack. It has been suggested that delicate hairs on the undersurface of the cerci, two sensory appendages posterior to the abdomen, sense the strength and direction of air currents generated by an attack. In this way, the cockroach detects the attack and its direction.

12b-14 It is reasonable to suggest that this escape response is dependent upon

- Ap 2 (i) B

A the presence of mechano-receptors at the base of the cercal hairs.
B the release of a hormone from the cockroach's neuro-endocrine system.
C the action of neurones within the central nerve cord.
D the simultaneous contraction and relaxation of effectors.

12b-15 Evidence to support the original hypothesis stated above would include

- An 2 (i) D

A the escape response failing to occur when the hairs of the cerci are immobilized with wax.
B immobilization of the hairs of one cercus causing the cockroach to turn in a direction away from the untreated cercus when attacked.
C placement of a clear, plastic barrier between the cockroach and an attacker leaving the cockroach unaware of an attempted attack.
D removal of the hair of one cercus not altering the frequency of successful escapes.

The next 2 items refer to the following information:

The salt balance in the blood is controlled by anti-diuretic hormone (ADH). This hormone acts on the cells of the collecting ducts of the kidney making them more permeable to water and thereby allowing water to pass from the ducts into the surrounding blood supply. ADH is released in increasing quantities by the pituitary in response to changes in the salt balance of the blood.

12b-16 One might expect ADH secretion to increase from the pituitary if there is

- An 4 (i) B

A dehydration.
B a drop in the salt to water ratio in the blood.
C blood loss.
D a rise in the osmotic pressure of the blood.

12b-17 An increased output of urine could be expected from the following treatments.

- An 3 (i) C *

A Injection into the blood of a substance that inhibits the action of ADH on the collecting ducts.
B Surgical removal of the pituitary.
C Injection of a strong salt solution into the blood supply of the pituitary.
D Constriction of the blood vessels leaving the pituitary.

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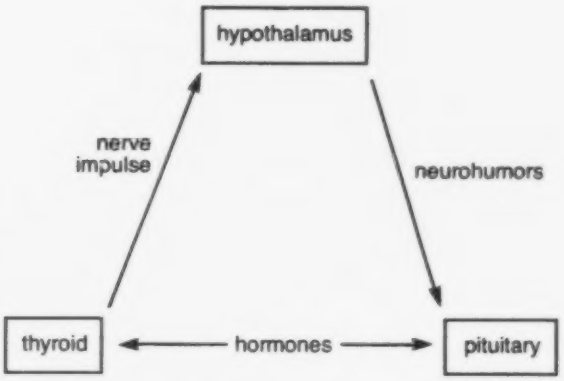
12c—Internal regulation by homeostasis

CORRECT response items

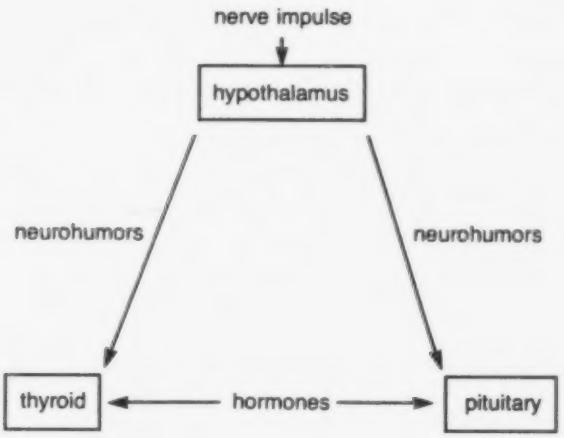
12c-1 – Co 2 (c) C Under nervous stimulation the hypothalamus secretes chemicals (neurohumors) into the blood vessels connecting it to the pituitary, and these chemicals trigger the production of the thyroid-stimulating hormone by the pituitary. The thyroid gland is stimulated to produce hormones which in turn suppress the production of thyroid-stimulating hormone.

Which one of the following most correctly represents the above information?

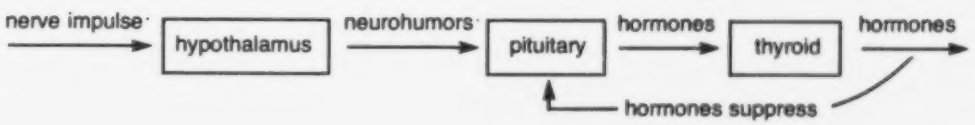
A



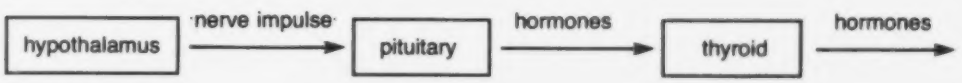
B



C



D



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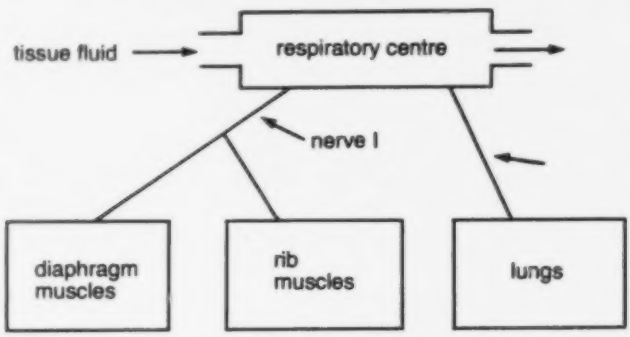
The next 3 items refer to the following information:

The normal breathing cycle in a mammal can be explained as follows:

Tissue fluid with a 'normal' bicarbonate ion (HCO_3^-) concentration passes over the cell bodies of the respiratory centre.

The cell bodies are sensitive to the concentration of HCO_3^- in the fluid.

When the cell bodies are stimulated nerve impulses are sent out along nerve I to the rib and diaphragm muscles, causing them to contract. The chest cavity enlarges, the lungs expand passively, and air is thus inspired. At the end of normal inspiration, stretch receptors in the lungs are stimulated and impulses travel along nerve II to the respiratory centre. These impulses inhibit the respiratory centre. Impulses along nerve I therefore cease, the rib and diaphragm muscles relax, the volume of the chest cavity decreases, and air is expired. A simplified diagram of the nerve pathways is shown below.



12c-2 – Ap 3 (c) A

What will happen if there is a rise in HCO_3^- concentration of the blood (and therefore the tissue fluid)?

A More impulses than normal will be sent along nerve I.
B Fewer impulses than normal will be sent along nerve II.
C The rate of breathing will remain the same as impulses are sent along both nerves I and II.
D Breathing will be slower since impulses along nerve II will be less frequent than normal.

12c-3 – An 4 (c) C

What is most likely to happen if nerve I is cut?

A The stretch receptors in the lungs will be continually stimulated.
B The rib and diaphragm muscles will remain contracted indefinitely.
C Inspiration will be impossible.
D The chest cavity will remain fully expanded.

12c-4 – An 4 (c) B

What is most likely to happen initially if nerve II is cut?

A More impulses than normal will reach the respiratory centre from the lung stretch receptors.
B The rib and diaphragm muscles will remain contracted.
C More impulses than normal will be sent out along nerve I.
D The rib and diaphragm muscles will relax to a greater degree than normal.

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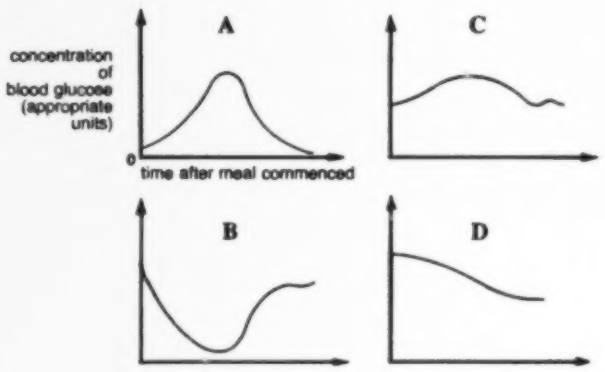
12c-5 – Co 5 (c) C

Which one of the following graphs most probably describes the concentration of glucose in a man's blood after a heavy meal of carbohydrates?



12c-6 – Kn 4 (c) D

Homeostasis in an organism may be described as a condition in which

A all its body functions are constant.
B the amount of food entering it equals the amount of wastes excreted and eliminated in a given time.
C the internal environment is not the same as the external one.
D the internal environment is relatively independent of the external one.

INCORRECT response items

12c-7 – Co 3 (l) D

Homeostatic regulation of body temperature requires that heat gain should equal heat loss.

With regard to temperature regulation in man, it is reasonable to state that

A heat loss from the lungs is not under regulatory control.
B metabolic heat gain is proportional to oxygen consumption.
C all other things being equal, a clerk at work would have a lower heat gain than a builder's labourer at work.
D temperature receptors in the skin are ultimately more important than temperature receptors in the central nervous system.

12c-8 – Ap 2 (l) A

Each of the following is an example of the activity of a homeostatic mechanism.

A the alteration of human skin colour in response to exposure to strong sunlight
B the constancy of temperature of a bird (temperature is found to be 40.5 ± 2.8 °C)
C the maintenance of the concentration of sodium ions in the blood of a flathead at a different level from that of the salt water in which it lives
D the excretion by the bug *Rhodnius*, after a meal of blood, of a fluid containing 15 times as much potassium as its own blood

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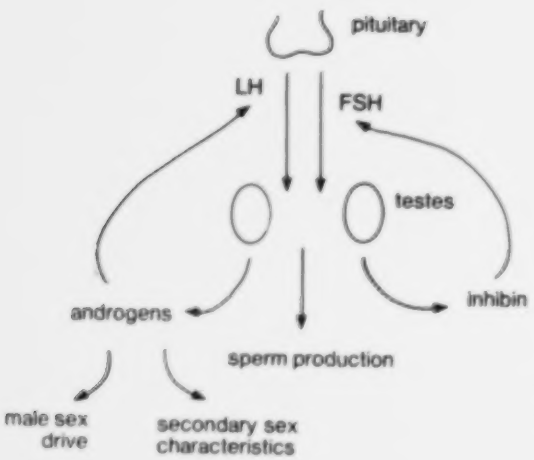
The next 2 items refer to the following information:

Sperm and hormone production in the mammalian testes is under the control of two hormones released by the pituitary gland. Follicle stimulating hormone (FSH) causes the testes to increase sperm production, and luteinizing hormone (LH) causes an increased output of androgens. Androgens are the male sex hormones that are responsible for the sex drive and development of secondary sexual characteristics.

It has recently been postulated that the testes also release another hormone called inhibin, that serves to regulate sperm production by inhibiting the output of FSH from the pituitary in feedback fashion.

The control mechanisms thought to be involved are shown.



12c-9
12b
An
3
(i)
B

Each of the following would support the hypothesis concerning the existence of the hormone inhibin.

A Increasing doses of testicular extract on pituitary cells grown in tissue culture cause proportional falls in FSH levels within the cells.

B Injecting testicular extract into normal individuals increases sperm production.

C Prevention of release of inhibin by testes leads to increased sperm production.

D Loss of one testis leads to increased sperm production in the other.

12c-10
17e
An
3
(i)
D

If this hypothesis is correct, then

A there would be high FSH levels in men who had no sperm in their ejaculate because of damaged testes.

B administration of inhibin could act as a male contraceptive by reducing sperm production but not sex drive.

C a high rate of sperm production would lead to a drop in the level of circulating FSH.

D there would be high levels of FSH and LH in males with reduced sex drives.

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The next 2 items refer to the following information:

In mammals the concentration of sodium in the blood is under homeostatic control.

The sodium concentration determines, to a large degree, the total plasma volume, and consequently the blood pressure. Increased sodium concentrations in the blood lead to increased retention of water in the kidneys, and thus increased plasma volume and blood pressure.

Information regarding the amount of sodium in the blood can therefore be given by stating the sodium concentration, the plasma volume, or the blood pressure.

The concentration of sodium may be regulated by controlling two kidney processes:

I the rate of plasma filtration; and
II the rate of tubular reabsorption.

Control may be neural, hormonal, or both.

The *hormone* aldosterone, which is produced by the adrenal cortex, stimulates tubular reabsorption.

12c-11 It would be reasonable to conclude that

An 3 (I) D

A patients with chronic marked reductions in filtration rate would tend to have higher than normal blood sodium concentrations.

B patients with diseased adrenal glands would tend to excrete large quantities of sodium in the urine.

C patients suffering from a deficiency of aldosterone would tend to have low blood sodium concentrations.

D patients with low blood pressure and with their adrenals removed would tend to have higher than normal blood sodium concentrations.

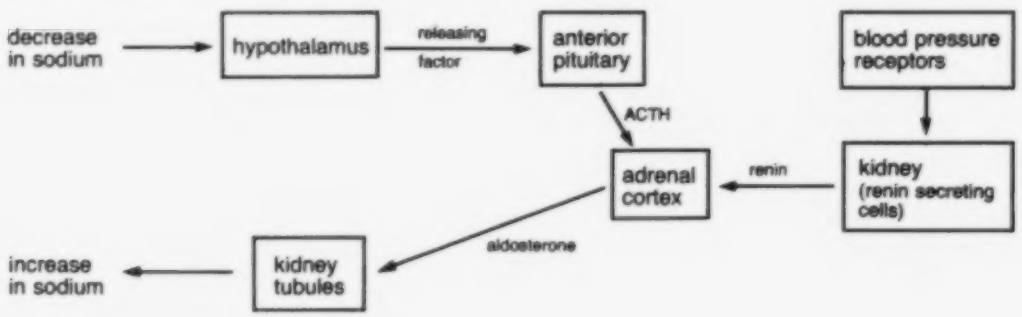
The next item refers to the following ADDITIONAL information:

Other *hormones* that are involved in the control of sodium concentration include:

Hormone	Endocrine gland	Action
Renin	Kidney	stimulates aldosterone secretion
Adrenocorticortrophic hormone (ACTH)	Anterior pituitary	stimulates aldosterone secretion

Nerves that are involved in the control of sodium concentration include some that are associated with blood pressure receptors in the kidney.

The following model has been proposed to explain the homeostatic control of sodium concentration in the blood.



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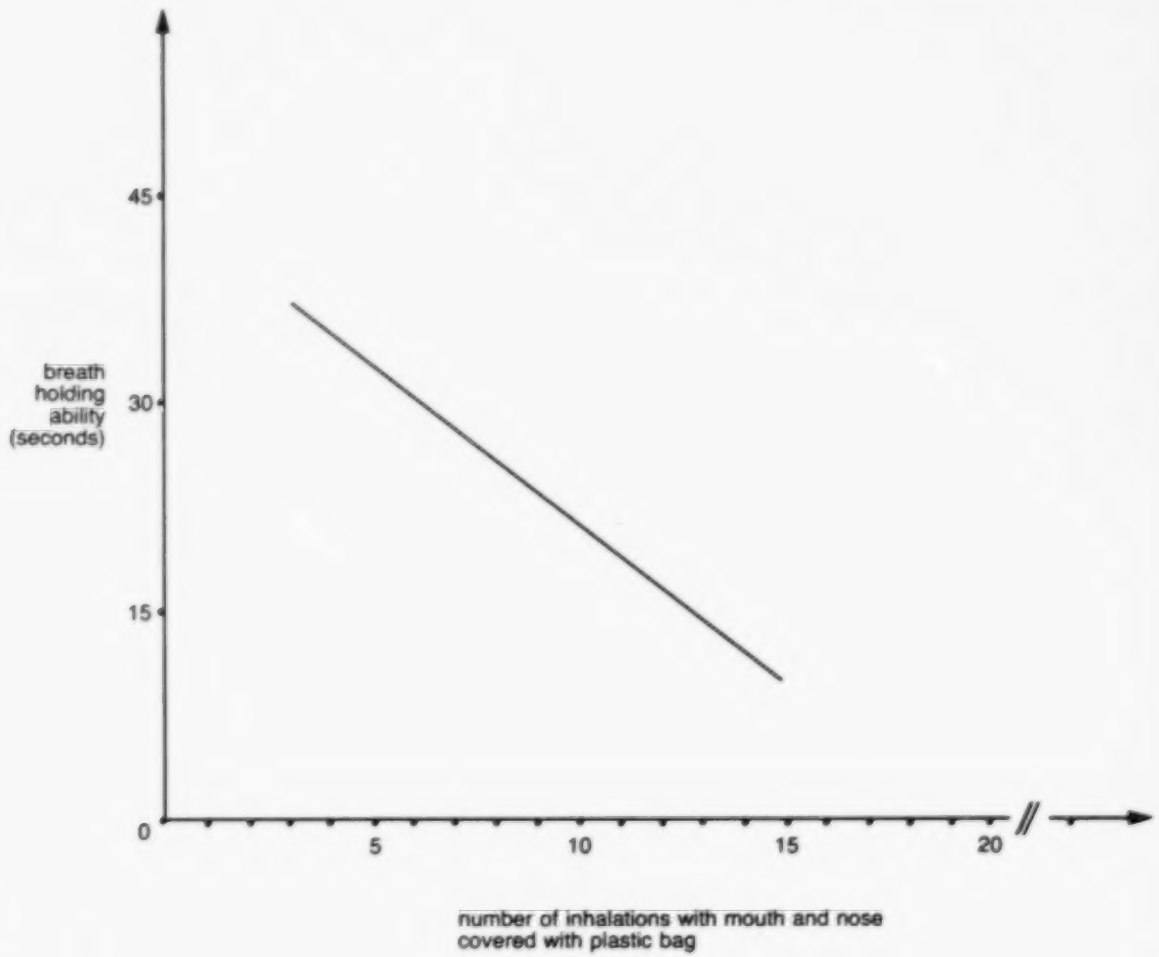
12c-12 17d Co 2 (I) C

If this model is **true** then an increase in blood sodium concentration would occur if

- **A** there were an increase in the production of releasing factor.
- **B** the adrenal cortex were to secrete aldosterone continually.
- **C** there were a decrease in the amount of ACTH produced.
- **D** renin were injected into the adrenal cortex.

12c-13 17e An 3 (I) C

Several students conducted an experiment to test the hypothesis that breath-holding ability is affected by rebreathing exhaled air. The students inhaled and exhaled for different numbers of times into a plastic bag, and after each time recorded how long they could hold their breath. The results were graphed as follows:



It may be concluded from the data that

- **A** the accumulation of CO_2 in the body creates an increasing need to inhale fresh air.
- **B** the control of breathing is to a certain extent, involuntary.
- **C** at between 20 and 30 inhalations the ability to hold one's breath would be zero.
- **D** humans have a low tolerance of higher than normal blood CO_2 concentrations.

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Chemical Regulation in Plants

12d—Angiosperm response throughout development; chemical control

CORRECT response items

12d-1 – An 3 (c) C

An experiment was set up using single leaves of a plant. Light-tight barriers were placed across each leaf so that each half of the leaf was exposed to either long days or short days. Three separate set-ups were used as shown in the diagram.

From these observations it would be reasonable to conclude that

A the plant used in the experiment is a long-day plant.
B leaves produce an inhibitor which prevents flowering.
C a chemical which initates flowering is translocated in the phloem.
D a chemical which initiates flowering is released from the tip of the leaf when the tip is exposed to short days.

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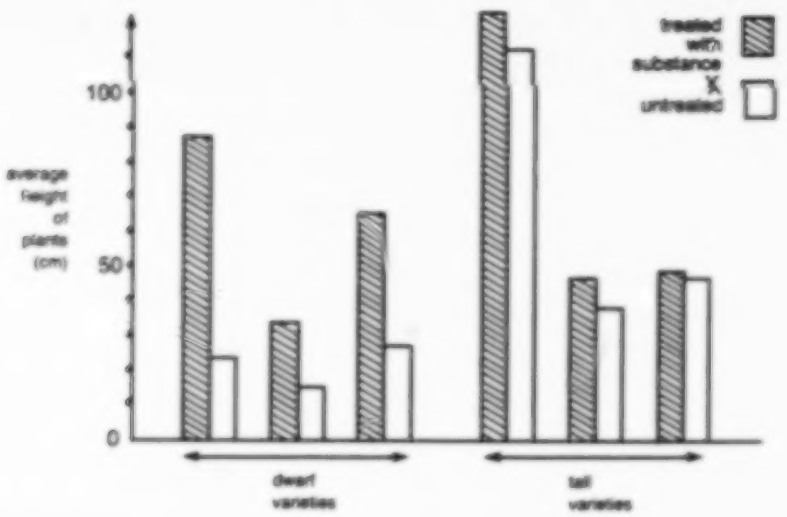
12d-2 – Co 3 (c) B

The effect of substance X on shoot lengths of dwarf and tall varieties of plants was investigated. The results are shown below.



It is reasonable to state that substance X

A has a greater growth-promoting effect on tall varieties of plants than on dwarf ones.
B has a variable effect on the growth-promotion of different tall plants.
C retards growth in height of tall varieties.
D promotes the growth of all dwarf plants by the same proportion.

12d-3 – An 3 (c) D •

Four groups of plants of the same species were treated in the following way with the results shown.

Treatment	Observation
Terminal bud removed.	Main stem grew slowly. Lateral buds grew.
Terminal bud removed and replaced by agar block with auxin.	Main stem continued to grow. Little or no lateral bud growth.
Terminal bud removed and replaced by plain agar block.	Main stem grew slowly. Lateral buds grew.
Control	Main stem continued to grow. Little or no lateral bud growth.

From these observations it is reasonable to conclude that

A lateral buds inhibit the release of auxin.
B auxin is not produced by lateral buds.
C removal of growing tips is likely to inhibit the growth of the plant.
D the auxin concentration that stimulates stem growth inhibits the growth of lateral buds.

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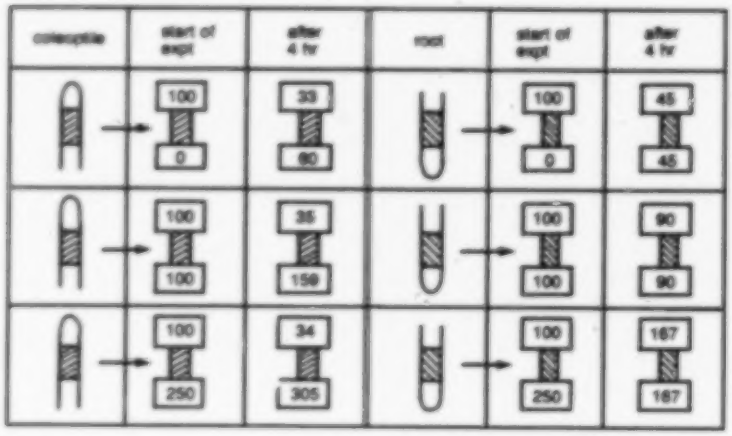
12d-4 12b Co 4 (c) C

Blocks of agar containing various amounts of auxin were prepared. The blocks were then placed at either end of vertical coleoptile sections or vertical sections of roots and left to stand for four hours.

The results were as follows, where the numbers shown in the agar blocks represent the relative amounts of auxin at the start and end of the experiment.



It would be reasonable to conclude that

A auxin can move either up or down a coleoptile.
B root tissue is capable of breaking down auxin.
C in coleoptiles, auxin moves through living tissue.
D in roots, auxin moves against a concentration gradient.

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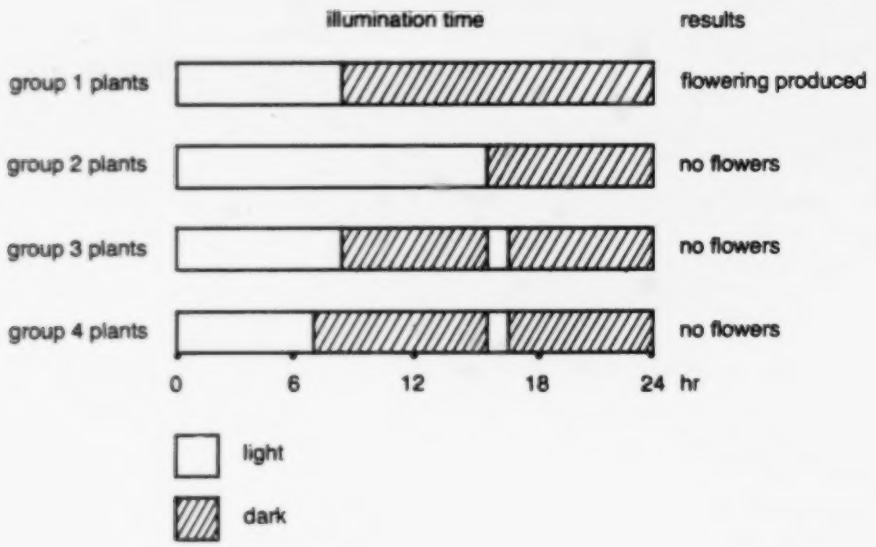
12d-5 17d An 2 (c) D

A series of experiments was conducted to investigate the flowering of *Chrysanthemum* plants. Young plants were exposed to differing amounts of light over consecutive 24 hour periods.



From the results above, flowering in *Chrysanthemum* plants is determined by

A equal periods of light and dark.
B total periods of darkness rather than the total periods of light.
C a short period of light.
D a certain period of uninterrupted darkness.

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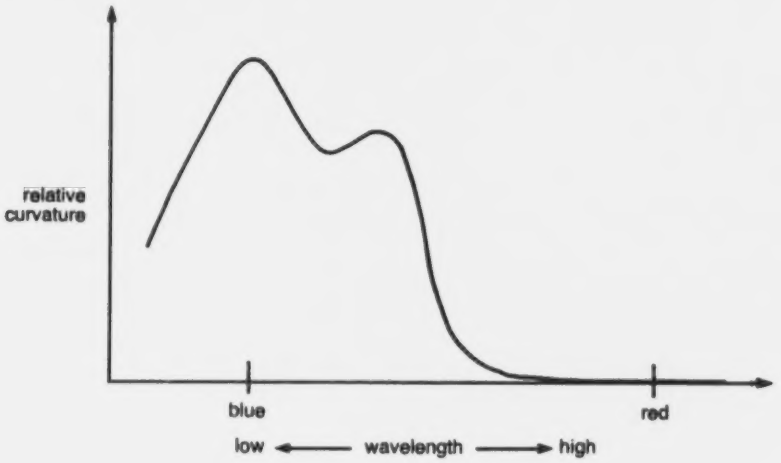
12d-6 The relationship between the curvature of an oat coleoptile and the wavelength of light to which it is exposed is given in the following diagram.

An 5 (c) A



Oat coleoptiles normally contain the pigment carotene. It has been suggested that differences in curvature of oat coleoptiles occur because carotene absorbs shorter wavelengths of light but does not absorb longer wavelengths of light.

You would obtain additional useful data by

A determining whether blue light causes curvature of oat coleoptiles known to lack carotene.
B investigating the effect of different intensities of blue light on the curvature of oat coleoptiles containing carotene.
C investigating the effect of intermediate wavelengths of light on the curvature of oat coleoptiles known to lack carotene.
D analysing the tissues of other plants for carotene.

INCORRECT response items

12d-7 Nastic movements are seen in

Co 4 (I) B

A the opening and closing of stomata.
B an oat coleoptile growing towards the sun.
C the 'sleep movements' in bean plants.
D a flower head closing in response to weak light.

12d-8 The following compounds are classified as plant hormones.

Kn 2 (I) C

A gibberellin
B abscisic acid
C phytochrome
D cytokinin

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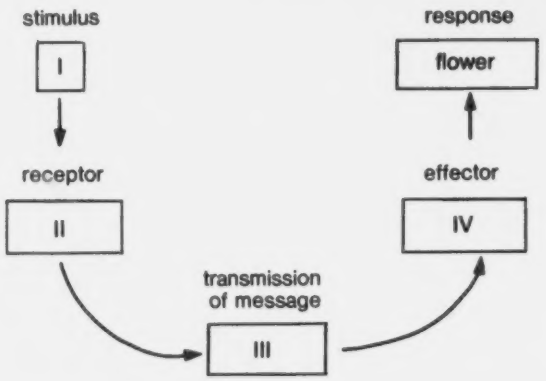
12d-9 The diagram shows a stimulus–response model for flower development in a short-day plant.

Kn
4
(I)
A

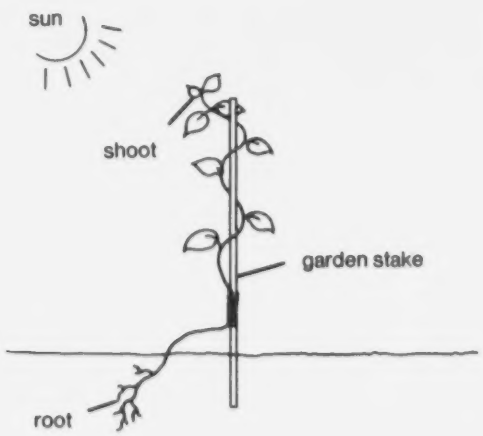


The numbers correspond as follows

A I period of continuous illumination
B II phytochrome
C III plant hormone
D IV meristem of flowering shoot

12d-10 The diagram shows how a climbing bean plant grows with the support of a garden stake.

Co
3
(I)
B



The growing bean plant probably

A produces auxins in response to daylight.
B ceases responding to stimuli at night.
C responds to gravity as well as light.
D is sensitive to the touch of the stake.

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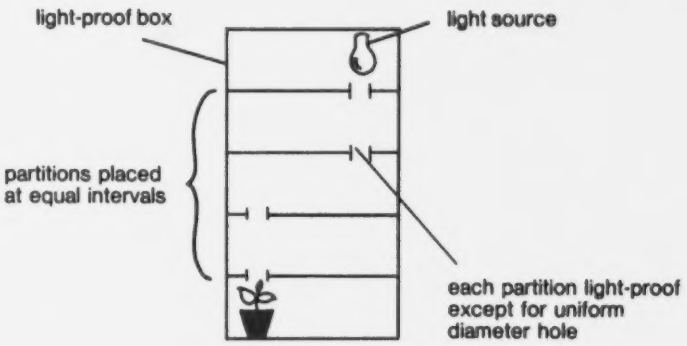
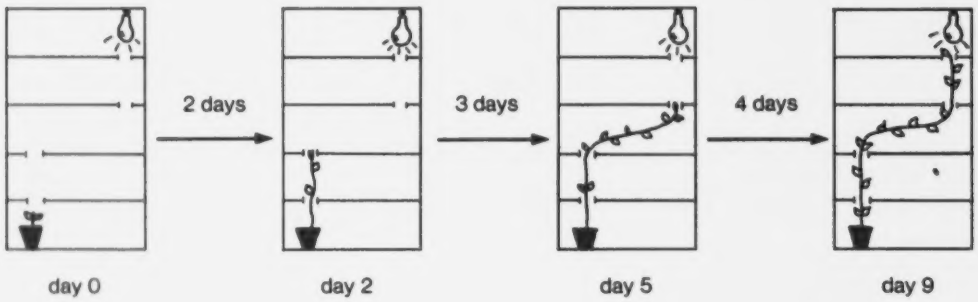
12d-11 **12b** **Co** **5** **(I)** **B**

An oat seedling is grown in the specially designed light-proof box shown in the diagram. The inside of the box is coated with a non-reflective material to avoid reflection inside each chamber.


light-proof box
light source
partitions placed at equal intervals
each partition light-proof except for uniform diameter hole

The growth of the seedling at the end of three successive intervals over a nine-day period was observed as follows:



From the demonstration it could be stated that

A the direction of light determines the shape of the growing shoot.
B light stimulates the growth of the growing shoot.
C the rate of seedling growth is not constant.
D the seedling shoot is positively phototropic.

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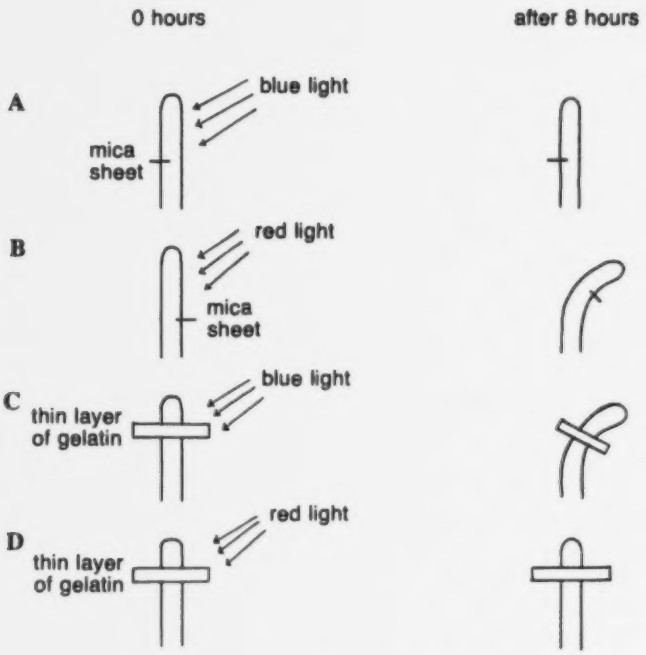
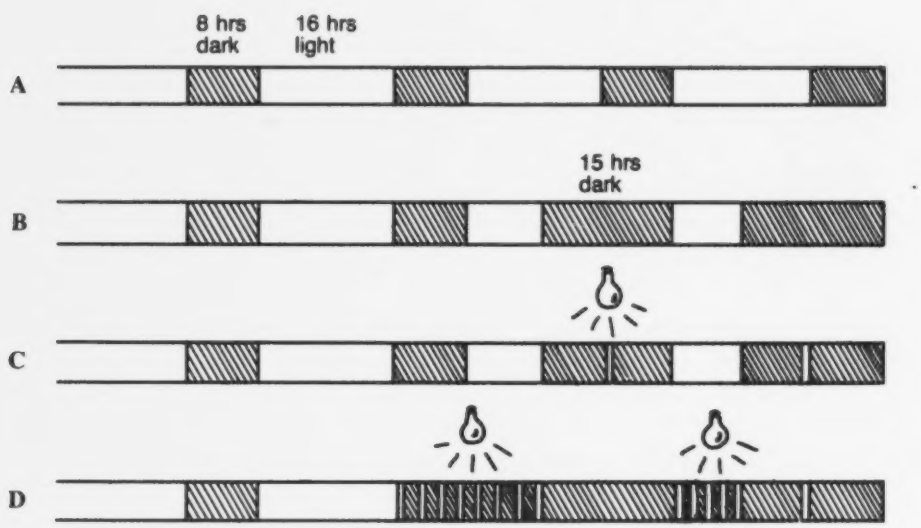
12d-12 Phototropism is the growth response of a growing shoot or coleoptile to certain wavelengths of light. Each of the following results would be expected in experiments set up to demonstrate this type of tropism.

– Co 5 (I) B



12d-13 A plant which normally only produces flowers in autumn or early spring could be prevented from flowering by subjecting it to the following periods of light and dark.

– Ap 1 (I) B *



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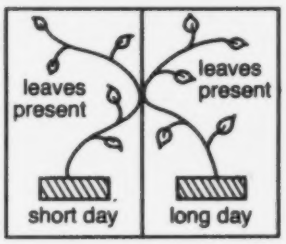
12d-14 – Ap 2 (I) D *

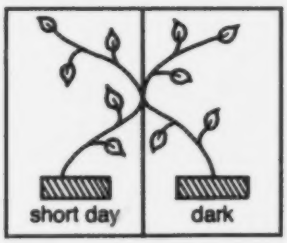
Four groups of two short day plants connected by a graft are set in separate light-tight chambers. Each of the four groups are subjected to different light conditions.

Flowers will be produced on both plants in each of the following.

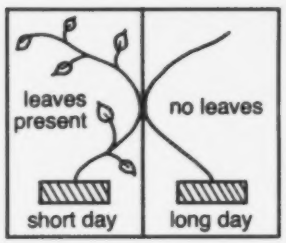
A



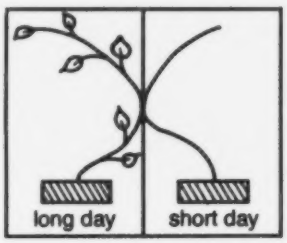
C



B

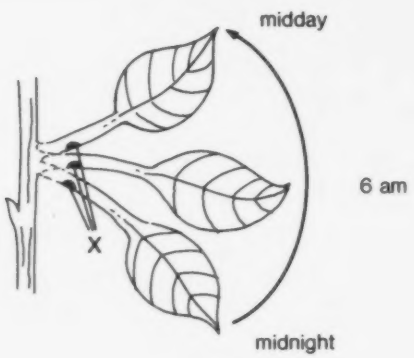


D



12d-15 17k 3 (I) C

An hypothesis put forward to explain the 'sleep movement' in bean leaves is based on findings which suggest that in plant cells there is a relationship between the build-up of potassium ions and the concentration of auxins. Cells in which there is a high concentration of auxin take in potassium ions, whereas cells lose potassium ions when the auxin concentration is low. The diagram shows the change in position of a bean leaf over a 12-hour period. The position of a group of cells on the lower side of the leaf-stalk is marked for reference.



From the above information, and your knowledge of osmosis, you would expect to find in a cell at position X at mid-day

A a high concentration of auxin.
B an increase in cell volume.
C potassium ions moving out of the cell.
D water moving from the cell vacuole into the surrounding cytoplasm.

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Behaviour Patterns

12e—Normal functioning and reproduction are aided by behaviour

CORRECT response items

The next 2 items refer to the following information:

Two subspecies of American deer mice show distinct preferences for particular habitats. One subspecies prefers to live in fields and to avoid wooded areas; the other lives in woodlands. A series of experiments was designed to test how the deer mice chose their particular habitat.

The investigation used the subspecies which prefers to live in open fields. Large experimental enclosures containing pens were constructed outdoors. Five of these pens were in open field and the other five in a woodland. All the pens were interconnected so mice could move freely from one pen to any other. Each time they moved, however, a recorder was activated. The scientists conducting the study compared the time spent outside the nest boxes in woods and fields respectively by groups of mice from different stock and with different experiences.

The results of the experiments are summarized below:

Stock	Experience	Group no.	Results
Grassland field stock	Fresh from field	I	Strong preference for grassland habitat
Laboratory stock	No field experience at all. 12 to 20 generations removed from those with field experience	II	No real preference for either habitat
Grassland, field stock	Offspring born and raised in laboratory separate from parents	III	Strong preference for grassland habitat
Laboratory stock 12 to 20 generations removed from those with field experience	Offspring raised in grassland	IV	Strong preference for grassland habitat

12e-1 It is reasonable to conclude that

17d
An
3
(c)
D
*

A group IV was used as a control group to help evaluate any effects of the enclosure itself.

B the marked preference for grassland habitat which would have been present in the ancestors of group II mice was probably lost within 8 generations.

C choice of habitat in deer mice must be learned.

D the results for group III mice indicate that experience in the grassland is not a necessary prerequisite for habitat selection.

12e-2 In order to learn more about the development of habitat preference in young deer mice, which of the following experiments would provide additional useful data?

17d
Ev
4
(c)
C
*

A Expose mice from group I to single stimuli designed to simulate different aspects of the natural grassland habitat; then test them in the large enclosure.

B Raise litters of field-bred mice with foster parents from grassland habitat to determine whether the young learn habitat preference from their parents.

C Restrict group IV animals to the grassland habitat for various periods in their development in order to determine the critical stage when habitat preference is 'imprinted'.

D Take fresh grassland stock and keep in the laboratory for up to 12 generations, testing the offspring of each successive generation for their habitat preference.

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12e-3 – Co 1 (c) B *

A species of caterpillar exhibits an instinctive behaviour where the caterpillars form chains in which each caterpillar attaches itself to the rear of the one in front. If a complete ring of these is formed on the edge of a saucer the caterpillars will continue to circle around the edge, each one remaining attached to the one in front.

This behaviour will probably continue until

A the leader moves away from the rim and the others follow.
B one falls off and a leader is thus created.
C they decide to break away in search of food.
D they realize they are getting nowhere and so break away to form a new chain.

INCORRECT response items

12e-4 – Co 2 (i) C

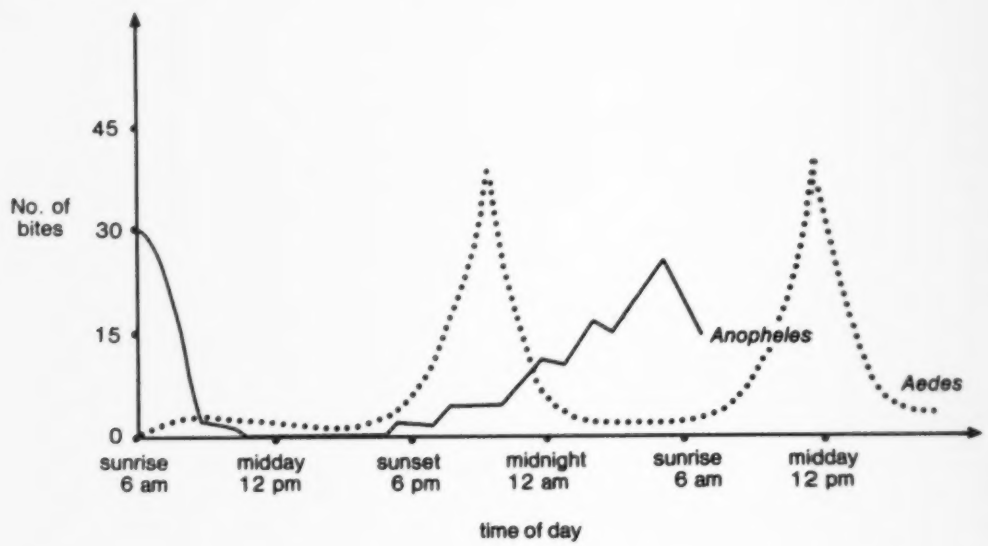
There is a sequence of steps in the life of a kangaroo.

Each of the following can be considered innate.

A At birth, the young kangaroo crawls from its mother's vagina, up her fur and into her pouch.
B The young kangaroo attaches itself to, and suckles from, a nipple.
C After a time the young kangaroo remains out of the pouch for familiar occurrences but heads for the pouch when something strange occurs.
D At sexual maturity the kangaroo mates with another kangaroo of the opposite sex.

12e-5 17f Co 4 (i) A

The following graphs refer to observations made on the biting behaviour of two species of African mosquitoes, *Aedes africanus* and *Anopheles gambiae*.



From the above results it could be reasonably concluded that

A biting activity is related to environmental temperatures.
B mosquitoes show circadian rhythm in their biting.
C changes in light intensity influence biting behaviour.
D *Anopheles* and *Aedes* both bite during daylight hours.

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12e-6 – Ap 1 (I) A *

There is a European caterpillar (*Ennomos*) which resembles a birch twig. Jays are birds which eat caterpillars and many other insects. Some jays were reared in captivity and never had any experience of caterpillars as food. A number of *Ennomos* caterpillars and a number of birch twigs of the same size were scattered over the floor of the jays' aviary. The jays ignored both twigs and caterpillars until, by accident, a jay trod on a caterpillar, which wriggled violently. This jay immediately ate the caterpillar and then began to pick up all twigs and twig-like objects in the aviary, discarding twigs and eating caterpillars. Other jays continued to ignore the twigs and caterpillars.

This study provides evidence that

A the prey of jays must move before they can see it.
B jays can learn by experience, but possibly not by imitation.
C originally the jay treated both twigs and caterpillars as twigs.
D the jay did not discriminate between twigs and caterpillars until after it picked them up.

12e-7 – An 3 (I) B *

The female wasp *Ammophila* normally shows three distinct phases of behaviour following fertilization:

Phase 1: Digs a burrow, puts a caterpillar in it, and lays an egg on the caterpillar.
Phase 2: Returns a few days later and adds more caterpillars. Her egg has now hatched into a larva which feeds on the caterpillars.
Phase 3: Returns again a few days later, adds more caterpillars, and then seals the burrow. The wasp does not visit it again.

In both Phase 2 and Phase 3 the female wasp enters the burrow and appears to inspect the larva before she collects more caterpillars.

An experimenter found that if the wasp larva was deliberately replaced by a wasp pupa between Phase 1 and Phase 2, the female, after her Phase 2 inspection visit, did not collect more caterpillars, but instead immediately sealed the burrow, and omitted Phase 3.

The following statements are consistent with these observations.

A Phase 1 may be entirely instinctive.
B Phase 2 may be entirely learned.
C In her inspection visits the female assesses the stage of development of the larva.
D Whether or not Phase 3 occurs may depend on the results of the wasp's inspection in Phase 2.

12e-8 – Ap 3 (I) C

There are often individuals in any highly organized society who will sacrifice their own chances of survival or reproduction for the good of other society members. This is known as altruism, and the best known examples of this type of behaviour are found in social insects such as termites and bees. In termites, individuals belonging to a particular caste perform certain tasks. The task of the soldier caste, for example, is specifically to defend the colony. Termite soldiers are incapable of producing offspring or gathering food, and have to be fed by members of the worker caste who are also sterile. In a particular genus of harvester termite *Drepanotermes*, the soldiers accompany foraging groups of workers who often venture far from the safety of the mound. Should ants, or other predators, attack a group, the workers hurriedly retreat to the mound and seal the exit holes, leaving the soldiers behind to engage the predator, and to die either from wounds inflicted in combat, or eventually of starvation.

Some of the more important implications of altruism in highly social insects such as termites are that

A this behaviour involves co-operation between individuals who normally perform different tasks.
B the survival of reproductive individuals is ultimately more important to the society than the survival of non-reproductive members.
C this behaviour is learnt by individuals who have experienced incidents when the survival of the society has been threatened.
D the behaviour patterns of non-reproductive individuals are passed on to the next generation.

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12e-9 – Co 3 (i) D In areas frequented by anubis baboons, periods when food is abundant are interspersed with periods when food is scarce.

When food is scarce, baboon troops split into small foraging parties, each of only a few individuals. The animals travel more and have less time for sleep and social interactions compared with times when food is abundant.

This change in behaviour

A means the hungry baboons spend a higher proportion of their time in appetitive behaviour than fed baboons.

B indicates that the hierarchy of behaviour patterns differ between the hungry and fed baboons.

C would involve changes in internal body functioning.

D would result in more aggressive encounters between members of different parties than would otherwise be expected within the one large troop.

12f—Determiners of behaviour: heredity, experience, environment, physiology

CORRECT response items

The next 3 items refer to the following information:

Use the following key to indicate which type of behaviour is involved in the examples in the next 3 items.

Key:

A innate

B trial and error

C conditioned

D insight

12f-1 – Ap 1 (c) A * Dogs make scratching motions when the abdominal wall is tickled.

12f-2 – Ap 1 (c) A * A new-born baby's fingers close over an object placed in the palm of its hand.

12f-3 – Ap 1 (c) C * A sheep-dog follows at the heels of its owner. It is trained to do so by being called to heel, rewarded for staying there, and punished for straying away.

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The next 3 items refer to the following information:

The behaviour of animals is often described in terms of human emotions, understanding, and purposeful actions. This may be inaccurate as well as inappropriate since there is no evidence that all animals are capable of such feelings and action.

12f-4 On the above grounds, only **one** of the following statements is scientifically acceptable.

17f Ap 1 (c) D *

Which one?

A As the butterfly was hungry, it flew around searching for food.

B When it detected the scent of a flower, the butterfly fluttered around excitedly.

C The butterfly alighted on the flower and uncoiled its long 'tongue' (maxillae) seeking the nectar secreted by the flower.

D The 'tongue' (maxillae) of the butterfly moved around amongst the inner parts of the flower.

12f-5 Which **one** of the following statements is expressed in scientifically acceptable terms?

17f Co 1 (c) C *

A The St Andrew's Cross spider commenced to spin a web in order to trap its food.

B After completing the main structure of the web, the female added extra strands at the centre so that the web would be strong enough to restrain the larger insects.

C Later the female moved to a position near the centre of the web and laid its eggs in pairs along three or four of the strands.

D During this time, so as not to be eaten by the female, the male spider lived mainly on the outer strands of the web.

12f-6 Tree frogs usually have certain structural characteristics which differ from those of frogs living in other environments.

17f Co 1 (c) C *

With respect to these characteristics, and the information supplied above, which one of the following statements is correct?

A In order to live amongst trees, tree frogs have developed means of climbing.

B On each finger and toe, tree frogs have developed a disc so that they can take a firm grip of branches.

C Tree frogs have strong front legs which appear to suit them to climbing in trees.

D The hind legs have remained large and strong as it is necessary for tree frogs to be able to jump from branch to branch.

12f-7 Some arctic mammals such as marmots hibernate during the winter, but birds from this region migrate south to the tropics for the winter.

– Co 1 (c) A

These two behaviours are similar because

A both represent adaptations to the problem of food availability in the arctic winter.

B both are means of maintaining normal body temperatures.

C both behaviours involve the seeking of a warm place in which to spend the winter.

D both are means of escaping predation during the winter.

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12f-8 Which one of the following responses is independent of previous experience?

–
Co
1
(c)
C
*

A Your mouth starts to 'water' when someone suggests an appetizing meal.
B You catch a ball which has been thrown to you.
C Your pupil dilates with decreasing light intensity.
D Your pulse quickens as you approach your driving test.

INCORRECT response items

12f-9 Each of the following would be regarded as a response.

–
Kn
1
(I)
B

A a horse rubbing itself against a tree
B a bright light shone in the eyes
C the germination of seeds
D flowers closing at nightfall

12f-10 Attachment is a common behaviour in farmyard birds.

–
Kn
2
(I)
D

This behaviour shows characteristics of imprinting because

A the birds may form an attachment with an animal of a different species.
B once an attachment is formed it usually remains.
C an attachment can be formed with a moving cardboard box.
D an attachment will occur at any time before all 'baby feathers' are lost.

12f-11 Willow warblers are birds which breed in Europe, migrate to Africa in Autumn and return to Europe during Spring. An experiment was designed to investigate this migratory behaviour. Four groups of fledglings were taken from their nests in Spring.

–
Co
1
(I)
A
*

Group A: kept in Europe at 21 °C constant temperature in 12 hours of light and 12 hours of darkness.
Group B: kept in Europe in the open, in their natural environment.
Group C: taken to Africa, kept at 21 °C constant temperature in 12 hours of light and 12 hours of darkness.
Group D: taken to Africa and kept in the open under natural conditions.

The scientist found that irrespective of treatment, all birds tended to show migratory behaviour in the Spring and the Autumn.

It is reasonable to predict that the migratory behaviour of willow warblers

A is circadian.
B is probably innate.
C is independent of variations in external stimuli associated with the different seasons.
D is dependent on an internal timing mechanism.

12f-12 Each of the following behaviours is innate.

–
Co
1
(I)
C

A a gull chick pecking at its mother's beak
B an ant-lion lava digging its pit
C a dog going to its bowl for water
D a new-born calf suckling its mother

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12f-13 – Co 3 (I) A

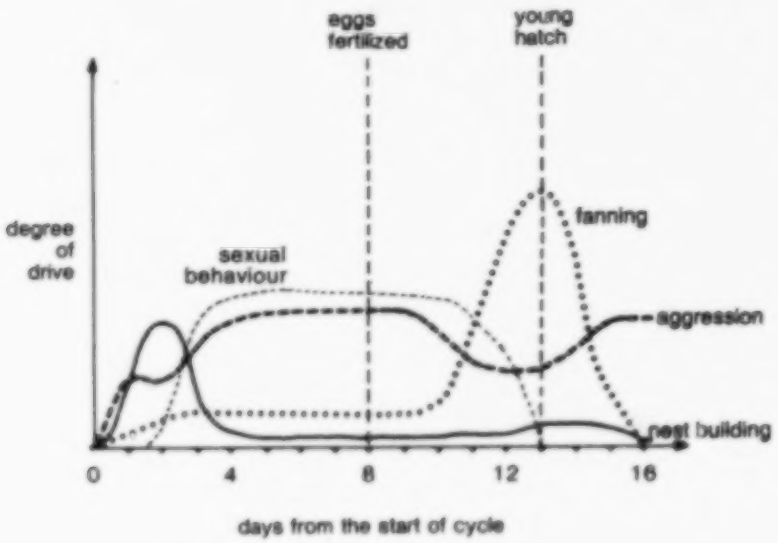
Cicadas hold a fascination for many people, whether biologists or not. The most fascinating thing about them is the timing of their life cycles. The female mates and lays eggs; the nymphs hatch, fall to the ground and remain underground for years. After growing for a specific time the nymphs emerge from the ground and climb the trunks of trees to await their transformation. The new adults emerge and the cycle begins again. In one American species all the adults emerge within two weeks of each other—after 17 years underground. The timing of the cycle is so precise that future generations can be predicted with pinpoint accuracy.

These behaviours would reasonably be

A an example of circadian rhythm.
B controlled by some biological clock mechanism.
C initiated by conditions within the organism.
D innate since no learning is necessary.

The next 2 items refer to the following information:

This graph illustrates the changing levels of behaviour of a male stickleback fish throughout its reproductive cycle.



12f-14 17e Co 3 (I) C *

From the graph it can be stated that

A nest building must be almost complete before the male stickleback will display sexual behaviour.
B fanning is necessary to circulate water over the eggs and not the young fry.
C nest building initiates high levels of aggression in male sticklebacks.
D male sticklebacks remain aggressive throughout their reproductive cycle.

12f-15 – Co 2 (I) D

There is a conflict of drives for sexual and aggressive behaviour in the male stickleback as the animal may receive two stimuli at once or be motivated simultaneously in more than one way.

The behaviour elicited will depend on the

A strength of each drive.
B fish's ability to display several behaviours simultaneously.
C presence of the appropriate releasing stimuli.
D conflict between sex and aggression occurring when the young hatch.

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12f-16 – Co 4 (I) D

Newly-hatched chickens peck at any spots on the ground, but as they grow older they cease this indiscriminate pecking.

This change in behaviour results from

A learning.
B habituation.
C maturation.
D conditioning.

The next 3 items refer to the following information:

A newly caught octopus was placed in a tank. When a crab was also placed in the tank, the octopus attacked and ate it.

When a white card with electrodes attached to it was placed next to the crab, the octopus received an electric shock when it attacked the crab and then retreated without its prey.

On each of 10 successive days six trials were carried out:
—three with a crab only;
—three with a crab and the card with electrodes.

After 10 days, the octopus attacked the crab if the card was absent, but would not attack the crab if the card was present, even if no electrodes were attached to the card.

12f-17 – Co 2 (I) A

The above results indicate an example of

A habituation.
B modification of a behaviour.
C conditioning.
D trial and error learning.

12f-18 – Ap 2 (I) A

The learning behaviour of the octopus in the experiment would depend upon

A the length of time taken to become immune to the electric shocks.
B the length of time it can remember between trials.
C the complexity of the situation to which it will respond.
D the past experience of this animal.

12f-19 – Ap 3 (I) C

In order to investigate the octopus' powers of sensory discrimination, the investigator could vary

A the colour of the card.
B the presence or absence of electrodes on the card.
C the number of times the card is used.
D the size of the card.

12f-20 17c Ap 2 (I) C *

A biologist reared a group of tadpoles in an aquarium. While the tadpoles were growing they fed on algae but when they developed into adults live flies were introduced into the aquarium. The young frogs were observed to immediately catch and eat them.

In one experiment, one of these newly-formed frogs, which had never caught prey, was placed in a container with several flies. Although the flies landed close to the frog, it did not move at all.

The following hypotheses are reasonable on the basis of the above information.

A The isolated frog did not 'recognize' the insect as prey.
B Pre-programmed abilities are involved in frog feeding behaviour.
C Frogs learn to catch prey by trial and error.
D Motivation plays a role in frog feeding behaviour.

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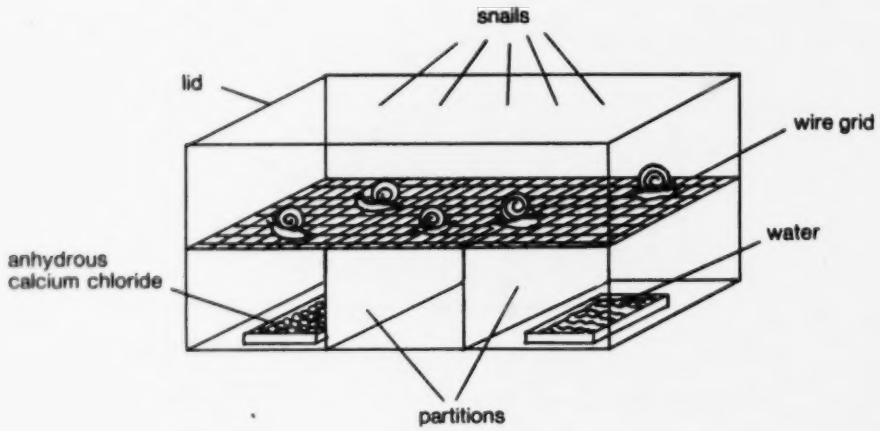
The next 2 items refer to the following information:

As shown in the diagram, some snails were placed in a humidity choice chamber which provided a humidity gradient.

The anhydrous calcium chloride gives a drier atmosphere on the left side of the chamber. The water gives a more humid atmosphere on the right.



The snails moved about the chamber but appeared to have difficulty moving when over the anhydrous calcium chloride. After spending several minutes there they exuded a bubbly mucus.

12f-21 – Co 3 (I) B

The snails in this side of the chamber would be displaying

A an innate behaviour.
B an example of habituation.
C an appetitive behaviour.
D a negatively reinforced behaviour.

12f-22 – Ap 2 (I) B *

One snail was seen to climb the wall at the extreme left-hand end of the chamber, withdraw into its shell and remain stationary for the remainder of the experiment.

This behaviour would probably

A increase its chances of survival.
B be an internally initiated form of behaviour.
C be reversed if the atmosphere became very humid.
D be a water-conserving device.

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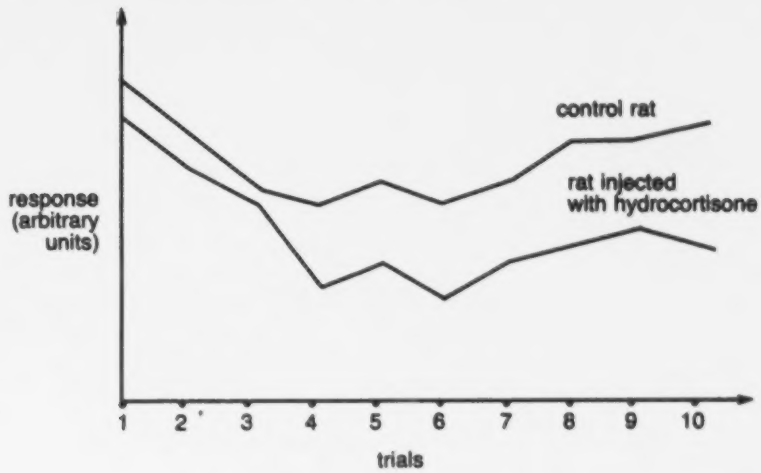
12f-23 – An 4 (I) A *

A rat is placed in a cage with a movable floor and exposed to a sudden, loud noise. The rat tenses or jumps, and the resulting movement of the floor is recorded on a chart. The results of 10 such trials for a control rat and one injected with hydrocortisone are graphed below. Hydrocortisone is known to prevent secretion of adrenocorticotrophic hormone (ACTH).



The results of this experiment show that

A the startle response in rats is automatic but its magnitude can be modified by learning.
B the internal conditions of the two rats differ to produce a difference in rate of learning.
C both rats have learned new behaviour patterns as a result of habituation.
D ACTH accelerates habituation to noises in rats.

12f-24 – An 3 (I) C *

Fermenting grapes were placed in five different containers. Twenty fruit flies were released 20 feet away.

The distribution of fruit flies around each container was noted 30 seconds after release. A count was also made 10 minutes after release.

The results were as follows:

	Description of container	Number of flies around container	
		30 seconds after release	10 minutes after release
I	clear glass, open top	7	17
II	clear glass sealed shut	0	0
III	clear glass covered with fine screen	7	2
IV	opaque glass sealed shut	0	0
V	opaque glass covered with fine screen	6	1

From these data and your knowledge of behaviour it would be reasonable to conclude that

A the flies engaged in trial and error behaviour.
B the flies showed appetitive behaviour in moving from dish to dish.
C the flies responded to the visual stimulus of the grapes.
D the odours of the fermenting grapes acted as a stimulus for the flies.

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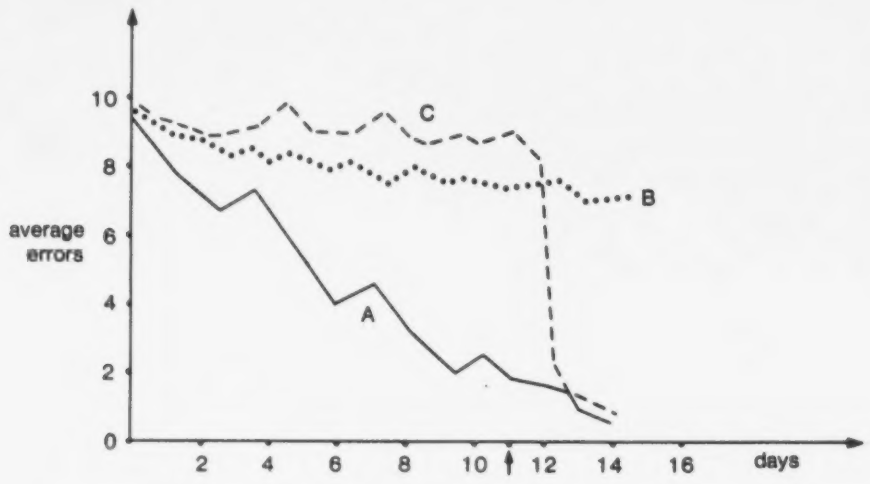
12f-25 17e Ap 2 (I) D In a behaviour experiment, three groups of rats were trained in a maze. The maze consisted of 14 T-junctions at which the rats could turn left or right. Rats in Group A were subjected to normal maze training with a food reward. Rats in Group B were not rewarded at all while Group C rats were rewarded from day 11 onwards.

The results are shown in the following graph.



The following statements are reasonable interpretations of the experiment.

A Rats are able to memorize details of direction.
B Initially the rats would have exhibited trial and error behaviour.
C Motivation can affect the way in which rats negotiate a maze.
D Learning in rats will occur only when a reward is given.

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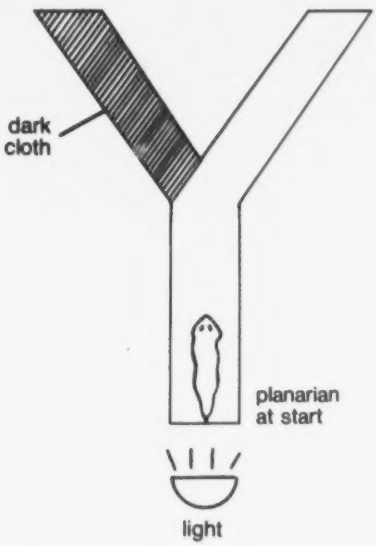
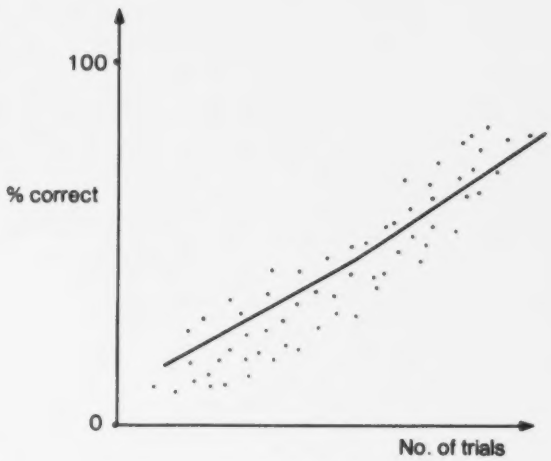
12f-26 17e Co 2 (I) A •

A study of the behaviour of the flatworm, planaria, was undertaken in the following way. As shown in the diagram, an animal was placed at the start of a Y-maze which had the left arm of the 'Y' covered with dark cloth. A bright light illuminated the maze from above, and another light source was placed at the start. When a planarian moved along the left hand path a correct response was recorded and the results of many trials with different worms were graphed. Each worm was used at least twice during the experiment.





The following hypotheses are supported by the data.

A The speed at which the planaria sought shelter increased as the experiment progressed.
B Behaviour patterns which are rewarded tend to be repeated.
C Planaria are able to respond to light stimuli.
D Planaria show some learning ability.

Regulation and Control in Multicellular Animals

12g—Nervous systems

CORRECT response items

12g-1 – Ap 1 (c) A

Nerve impulses can be traced by recording action potentials. An action potential is to be recorded in the brain and a stimulus is provided at a hind limb.

In this situation, which one of the following is **not** true?

A If a motor nerve to the limb is cut, there will be no recording.
B If the nerve from a touch receptor is stimulated, there will be a recording.
C Stimulation of certain areas in the spinal cord could cause a recording.
D If the spinal cord is cut below the brain there will be no recording.

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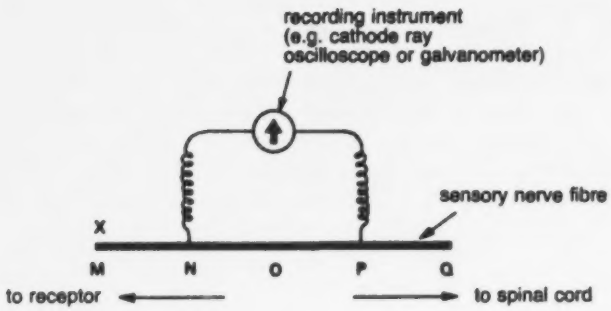
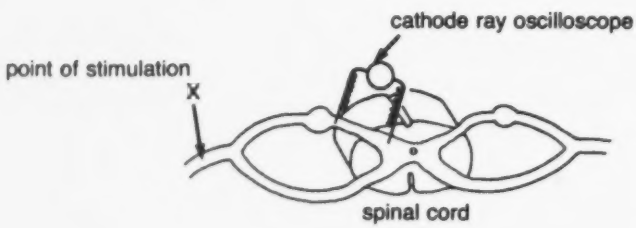
12g-2 – Co 1 (c) C The following diagram shows a sensory nerve fibre connected to a sensitive recording instrument.



Part of a sensory nerve fibre is stimulated at point X. As the impulse moves along the nerve, a reading will occur on the recording instrument when the impulse passes

A I and II simultaneously.
B III only.
C II only.
D I only.

12g-3 – Ap 1 (c) D The nerve shown in the diagram below was stimulated by a probe inserted at point X.



When the nerve was stimulated at X the tracing on the oscilloscope looked like this . After a few minutes the probe was removed and inserted nearby in the nerve. The tracing then looked like this

The most reasonable explanation for this difference is that

A the oscilloscope is recording the action potentials from motor neurones only.
B the action potentials from motor and sensory neurones produce different tracings.
C sensory neurones are easier to stimulate than motor neurones.
D only motor neurones were stimulated when the nerve was stimulated the second time.

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The next 5 items refer to the following information:

A motor neurone can be affected by two other types of neurone—**excitatory** neurones and **inhibitory** neurones. An impulse in the excitatory neurone causes the end of the axon to release a chemical substance which we will call substance K. Substance K diffuses from the excitatory neurone to the motor neurone cell body where, as a result, an impulse is initiated. This impulse then travels through the motor neurone towards the muscle. An impulse in the inhibitory neurone causes the release of a chemical substance which we will call substance M. When substance M diffuses from the inhibitory neurone to the motor neurone, no impulse is initiated in the motor neurone. If both substance K and substance M reach the motor neurone at the same time, substance M cancels the action of substance K, and so no nerve impulse is initiated in the motor neurone.

Figure 1 shows three neurones—motor, excitatory, and inhibitory.

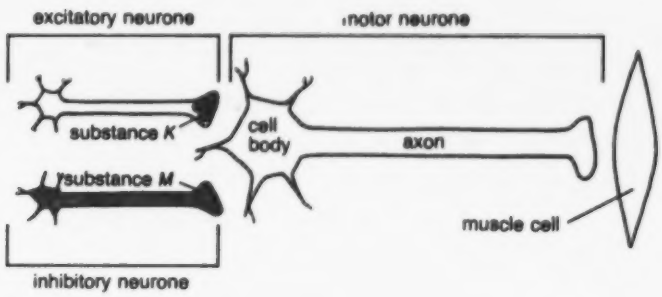

Figure 1

No nerve impulse is occurring in Figure 1. Figure 2 shows the situation when there is an impulse in the inhibitory neurone, and substance M has been released and has diffused towards the motor neurone. No impulse has been initiated in the motor neurone.

Note that there is no impulse in the excitatory neurone and so substance K has not been released.

When nerve impulses are present they are shown by arrows, and an inhibitory neurone is shown shaded.

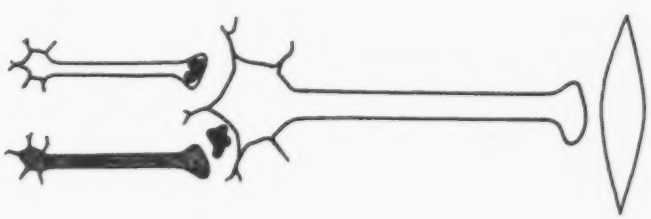

Figure 2

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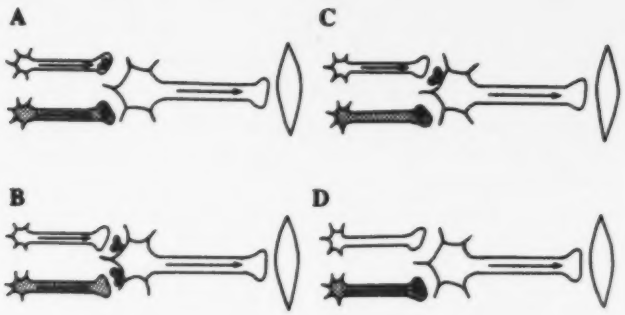
12g-4 Which one of the diagrams below is consistent with the data given?

–
Co
3
(c)
C



For the next 4 items, a simplified representation of neurones is used, as shown in Figure 3.

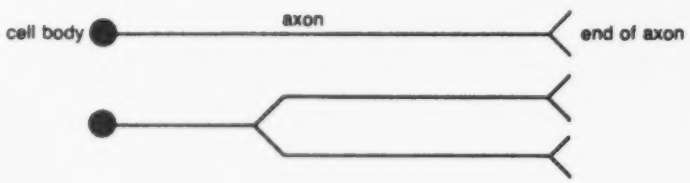


Figure 3

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The biceps and triceps muscles, shown in Figure 4, raise and lower the forearm. The figure also shows some of the neurones which control these muscles as the forearm is raised.

When the forearm is raised, the biceps contracts and shortens and the triceps is relaxed and stretched. If impulses stop coming to the biceps, it no longer remains contracted.

In the triceps there is a *stretch receptor*. This structure is activated when the triceps is stretched and it induces an impulse in the cell body X.

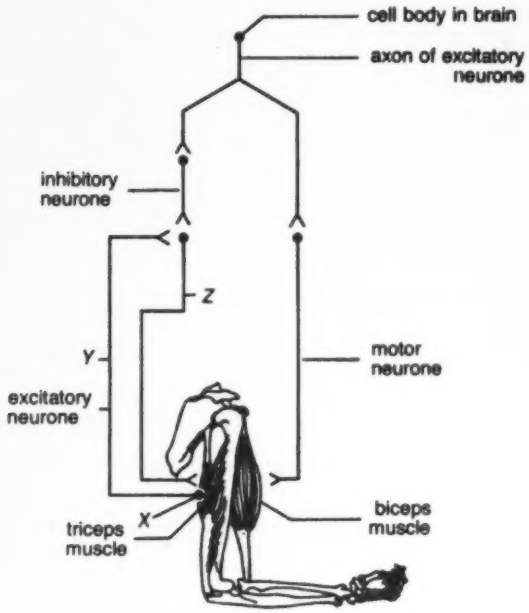

Figure 4

12g-5 The structure labelled Z is best described as an axon of

–
Co
2
(c)
A

A a motor neurone.
B an excitatory neurone.
C an inhibitory neurone.
D either an excitatory or an inhibitory neurone—it is impossible to decide from the information given.

12g-6 A subject wants to raise the forearm. Impulses originating in the brain reach the motor neurone associated with the biceps. The biceps contracts and the triceps is stretched.

–
Co
2
(c)
A

What happens in the structures Y and Z?

A Impulses travel in Y but not in Z because impulses also reach Z from the inhibitory neurone.
B Impulses travel in Y and Z but do not reach the brain because they are blocked by impulses from the inhibitory neurone.
C Impulses originating in Z pass to Y (thus by-passing the inhibitory neurone) and activate the stretch receptor near X.
D No impulses travel in Y or Z because impulses from the brain cannot reach the triceps since they are blocked by impulses from the inhibitory neurone.

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12g-7 – Ap 2 (c) C

Suppose a chemical which acts on the nervous system and blocks impulses in motor neurones is introduced into the system.

If impulses now come from the brain towards the biceps, the arm will be

A raised normally as the biceps contracts and the triceps relaxes.
B in a rigid state as both biceps and triceps contract.
C limp as neither biceps nor triceps contracts.
D fully extended as the triceps contracts and the biceps relaxes.

12g-8 – Ap 3 (c) B

Suppose a different chemical, which acts on the nervous system so that impulses in inhibitory neurones are blocked, is now introduced.

If impulses now come from the brain to the biceps, the arm will be

A raised normally as the biceps contracts and the triceps relaxes.
B in a rigid state as both biceps and triceps contract.
C limp as neither biceps nor triceps contracts.
D fully extended as the triceps contracts and the biceps relaxes.

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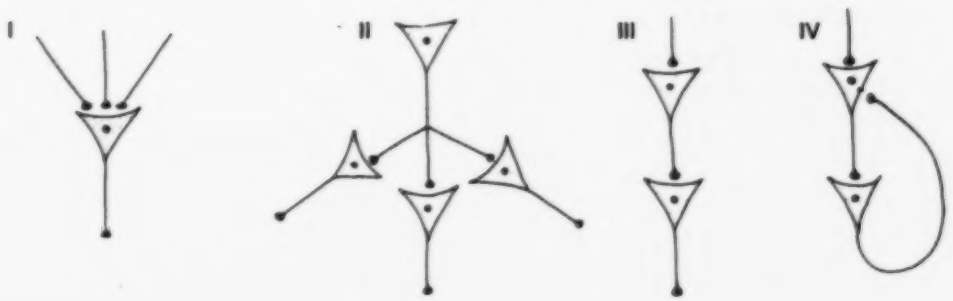
INCORRECT response items

12g-9 The following neuronal connections are found within the mammalian central nervous system.

–
Co
3
(I)
B

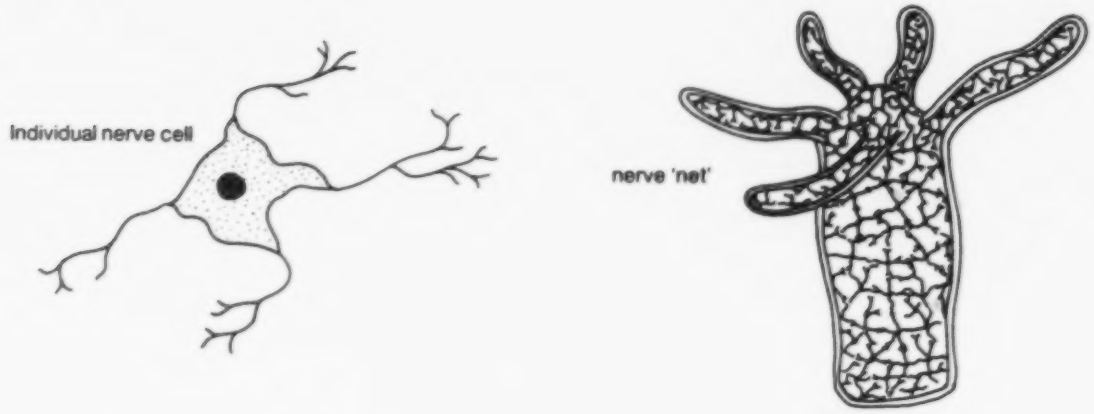


It would be reasonable to suggest that

A circuit I functions to integrate information.
B circuit II functions to assimilate information.
C circuit III functions to relay information.
D circuit IV functions in feedback control of information.

12g-10 *Hydra* is an animal found in aquatic habitats. The following diagrams show for *Hydra* the structure of an individual nerve cell (I), and the arrangement of nerve cells in the animal (II).

–
Ap
5
(I)
D



A stimulus to any point on the body surface of the animal may result in a generalized response (e.g. contraction of the whole body). Repeated stimulation results in the response fading in intensity until it ceases completely.

Similarities between the nervous system of *Hydra* and that of a mammal would include

A connections between adjacent nerve cells.
B nerve cells exhibiting fatigue.
C some nerve cells acting as interneurones.
D axons determining the direction of travel of an impulse.

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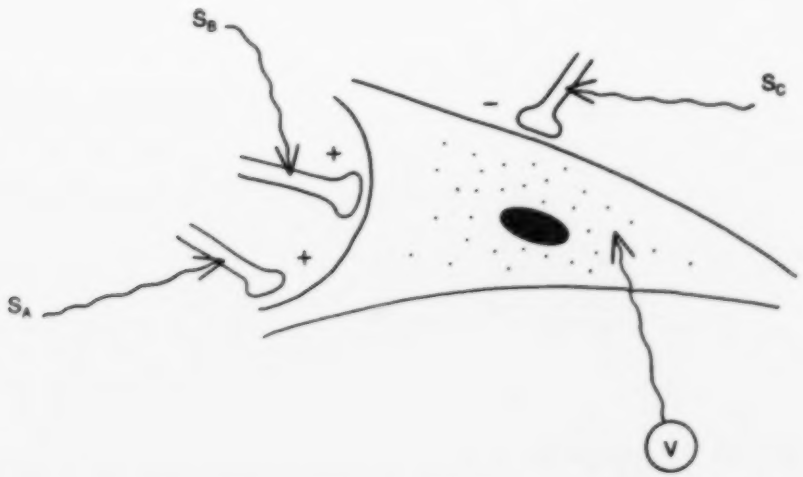
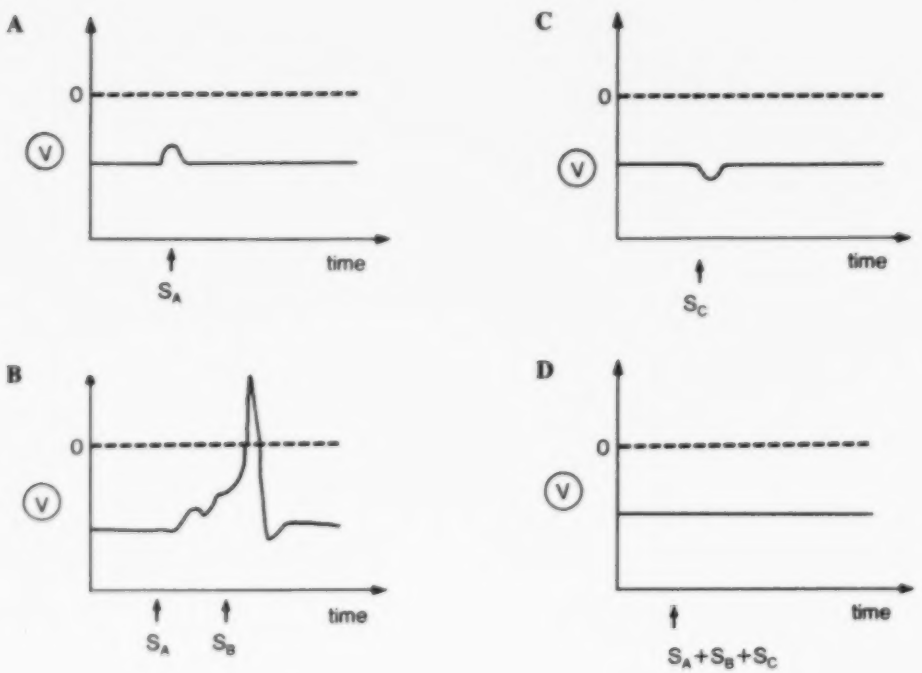
12g-11 – Ap 3 (I) D The diagram below shows the input of two excitatory axons and one inhibitory axon onto a nerve cell.



The following electrical recordings (V) from the nerve cell are consistent with the stimuli (S) shown.



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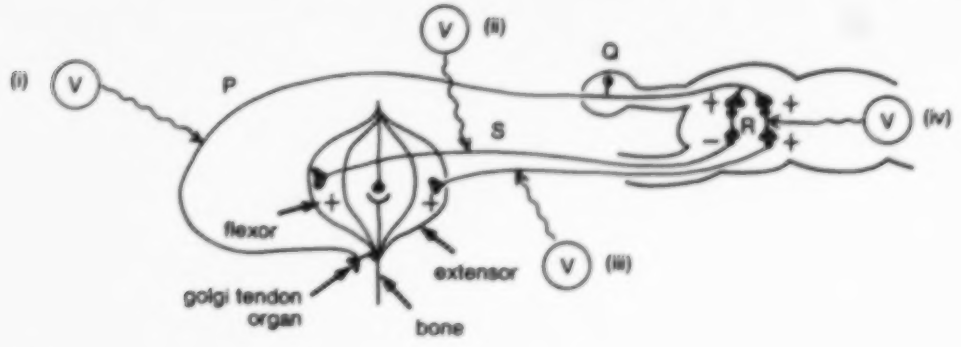
The next 3 items refer to the following information:

The golgi tendon organ is a receptor embedded in the tendons that monitors the tension generated by a contracting muscle. The organ is stimulated by increasing tension within the tendon. The nervous pathway connecting the organ with the muscles around a joint such as the elbow are shown (+ = excitatory, − = inhibitory).



Micro-electrodes to record nervous activity were placed at positions (i)—(iv) as shown.

12g-12 The diagram indicates that

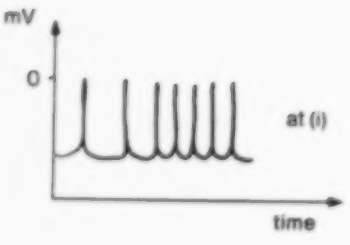
–
Co
5
(I)
C

A P is a sensory axon of the peripheral nervous system.
B Q is the dorsal root ganglion.
C R is a connector neuron within the white matter of the spinal cord.
D S is a motor axon of the peripheral nervous system.

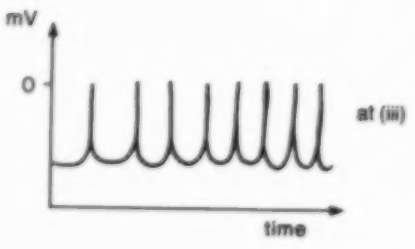
12g-13 With increasing tension in the tendon of the flexor, you would expect the following recordings from the electrodes.

–
Ap
4
(I)
D

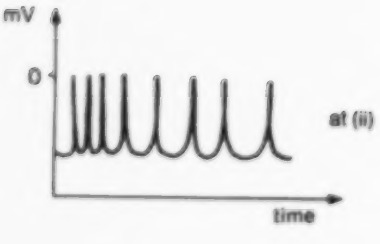
A



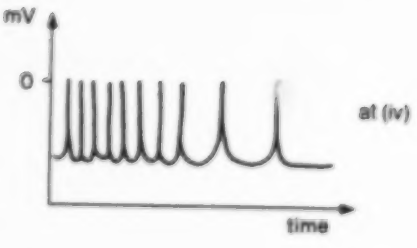
C



B



D



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12g-14 The following experimental procedures would produce the results indicated.

–
An
4
(I)
B

A Cutting P could lead to generation of potentially damaging tension in the limb during movement.

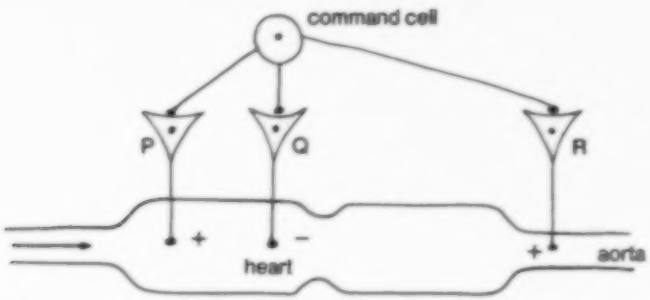
B Synaptic blockage at R would decrease tension in the flexor and increase tension in the extensor.

C Cutting S would cause a loss of tension in the flexor.

D Cutting the flexor tendon free from the bone would reduce tension development in the extensor as the flexor contracted.

The next 2 items refer to the following information:

The output of blood from the heart of the snail *Aplysia* is under the modulation control of one command cell. This command cell controls heart beat rate and aorta diameter, through synaptic connections with inhibitory and excitatory motor neurones. Increased activity in the command cell increases the output of blood from the heart—aorta system.



12g-15 You would expect that increased activity in the command cell would

–
An
5
(I)
D

A increase electrical activity in P.

B increase electrical activity in heart muscle cells.

C decrease electrical activity in Q.

D increase electrical activity in R.

12g-16 The action of the command cell could be explained by

–
An
5
(I)
C

A assuming that the synapse between the command cell and P is excitatory.

B assuming that the command cell receives synaptic input from receptors or from the central nervous system.

C assuming that the synapse between the command cell and Q is excitatory.

D assuming that the synaptic transmitter released by the command cell is inhibitory on R.

12g-17 When strychnine is given to an animal, the animal goes into severe convulsions caused by strong uncontrolled contractions of its muscles.

–
Co
3
(I)
B

This poison may be acting by

A blocking the effect of the inhibitory synapses on motor neurones.

B blocking the transmitter at the neuromuscular synapse.

C lowering the threshold of the motor neurone.

D increasing the input to the spinal cord from the sensory neurones.

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12g-18 – Kn 3 (I) C

The presence of synapses in mammalian nervous systems contribute to the functioning of such systems because

A neurones can be excitatory or inhibitory in action.
B action potentials pass in one direction only.
C an action potential in one neurone is transmitted and amplified to the next neurone.
D an action potential in one neurone can affect many adjacent neurones.

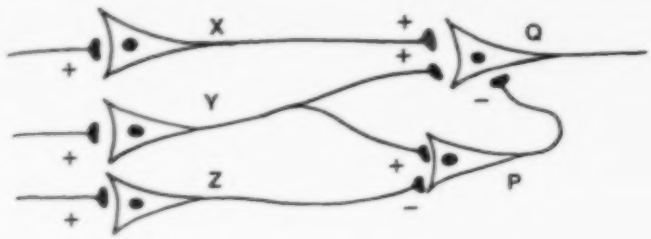
12g-19 – Kn 3 (I) C

The transmission of a nervous impulse in a mammalian motor neurone could occur if

A an action potential arrives at an adjacent interneurone.
B it is subjected to a sudden mechanical shock.
C the permeability of its cell membrane decreases.
D chemicals cause a depolarization of its cell membrane.

12g-20 – Co 4 (I) B

The arrangement of neurones in the mammalian central nervous system can be represented by means of the following diagram which shows some nerve cells and their interconnections.



An action potential would be expected in Q if

A an impulse arrives at X only.
B an impulse arrives at Y only.
C impulses arrive at X and Y simultaneously.
D impulses arrive at X, Y and Z simultaneously.

12g-21 – Ap 3 (I) A

Professor W. D. Paton of Oxford University wrote this figurative description of a person treated with the drug hexamethonium.

> He is a pink complexioned person, except when he has stood for a long time when be may get pale and faint. His handshake is warm and dry . . . he may laugh but can't cry. He dislikes speaking much unless helped with something to moisten the mouth and throat. He gets rather constipated so that his intake of liquid paraffin is high. He tends to get cold and keeps wrapped up.

The following could explain the action of the drug.

A blockage of impulse transmission along the axons of the peripheral nervous system
B inhibition of transmitter release within the ganglia of the autonomic nervous system
C blockage of receptors sensitive to impulse transmission within the ganglia of the autonomic nervous system
D blockage of the synapse between autonomic nerve fibre and effector

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CORRECT response items

The next 6 items refer to the following information:

Man may exhibit three emotional responses to a threatening situation: anger, depression, or anxiety (fear). A complex set of reactions prepares the body to meet the threat with 'fight' or 'flight'. These bodily reactions include deeper respiration, increased rate of heart-beat, increased blood pressure, and the release of sugar from the liver. These reactions result from the release into the blood stream of *adrenalin* (epinephrine) and *nor-adrenalin* (nor-epinephrine).

Experiments 1 and 2 described below studied the relation between the substances adrenalin and nor-adrenalin and the three emotional responses. The subjects of the experiments were healthy university students.

Experiment 1

Ten students were given a slow continuous injection of nor-adrenalin over a period of 60 minutes, at a rate known to increase the blood pressure by about 30 per cent. Ten minutes after the start of the injection, each student was injected with a standard dose of the drug *mecholyl* which is known to lower blood pressure. The effects of mecholyl on the blood pressure were noted.

The next day each student was put through the same procedure except that adrenalin (instead of nor-adrenalin) was given to raise the blood pressure. Again the effects of mecholyl on the blood pressure were noted.

The blood pressure change for one student is shown in Figures 1 and 2. Other students showed almost identical blood pressure variations. The pattern of blood pressure variation in Figure 1 is known as a TYPE N reaction to mecholyl, and that in Figure 2 is known as a TYPE E reaction to mecholyl.

Figure 1

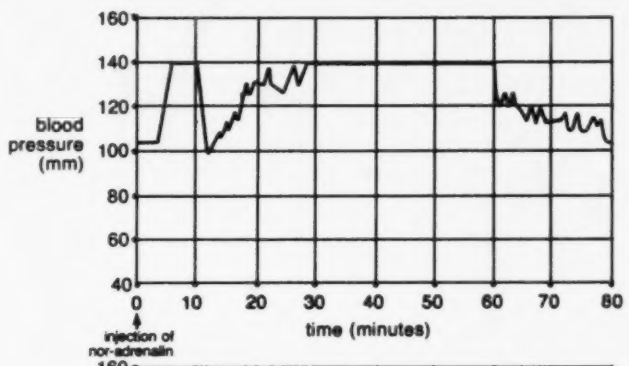
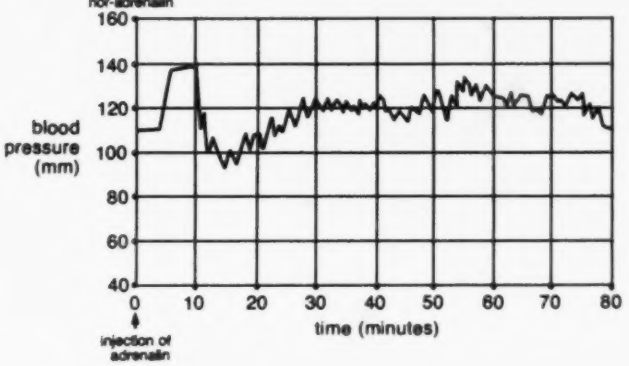


Figure 2



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12h-1 **17f** **An** **4** **(c)** **D**

In Figure 1 the decrease in the blood pressure noted after the 60th minute is most probably due to

A the decrease in the amount of nor-adrenalin.
B an increase in the amount of adrenalin present.
C the wearing off of the effects of mecholyl.
D an injection of mecholyl.

12h-2 **17f** **An** **4** **(c)** **B**

When mecholyl is injected into a person who is receiving a continuous injection of nor-adrenalin, the person's blood pressure

A increases suddenly then decreases suddenly, and then increases to its level just before the injection of mecholyl.
B decreases suddenly, then increases to its level before the injection of mecholyl.
C decreases suddenly, then increases to its level before the injection of nor-adrenalin and stays constant until the nor-adrenalin injection is discontinued.
D decreases suddenly, then increases slowly but never regains its level just before the injection of mecholyl.

12h-3 **17f** **An** **4** **(c)** **C**

Which one of the following is most characteristic of a TYPE N reaction to mecholyl?

A a sharp 5-minute increase followed by a sharp decrease in blood pressure
B a steady increase in blood pressure until a maximum value of 140 mm is reached
C a temporary decrease in blood pressure lasting no longer than 20 minutes
D a fluctuating blood pressure increasing to a peak about every 2 minutes

The next 3 items refer to the following ADDITIONAL information:

Experiment 2

Blood pressure measurements were made on a class of university students at a time when they were under stress, awaiting the results of an important competitive examination. Some of the students responded to this situation with elevated blood pressure and these students were given the standard dose of mecholyl. Two types of reactions to the mecholyl were noted—the students who were angry at others for the situation in which they found themselves had a TYPE N reaction; those who felt depressed or anxious had a TYPE E reaction.

After the results of the examination were announced and the student's blood pressure had returned to pre-stress levels, the students were again injected with the standard dose of mecholyl. All the students reacted in the same way to this injection.

12h-4 **17f** **An** **4** **(c)** **B**

A man becomes angry with the people with whom he works.

In his blood you would expect to find an unusually large amount of

A adrenalin.
B nor-adrenalin.
C mecholyl.
D a Type E substance.

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12h-5 17f An 5 (c) A

In Experiment 2 the experimenter injected the students with mecholyl again after the results of the examination were announced.

Which one of the following is the most likely reason for doing this?

A He wanted to see if the earlier different reactions to mecholyl were due to the temporary emotional states.

B He wanted to see if all the students had reacted to the stressful situation with increased blood pressure.

C He wanted to see what the students' reaction to mecholyl was when their blood pressure was normal.

D He wanted to see if the reaction to mecholyl was the same under all conditions whether stressful or not.

12h-6 17f An 5 (c) D

Which one of the following suggestions needs the results from **both** Experiments 1 and 2 to support it?

A Certain emotional states raise the blood pressure by measurable amounts.

B Nor-adrenalin and adrenalin raise the blood pressure for a certain period of time.

C Mecholyl affects the blood pressure for a certain period of time.

D Blood pressure reactions to adrenalin and nor-adrenalin are related to those produced by certain emotional states.

INCORRECT response items

12h-7 – Kn 2 (l) A

Each of the following hormones is produced by the human ovaries or testes.

A follicle-stimulating hormone (FSH)

B oestrogen

C progesterone

D testosterone

12h-8 – Kn 3 (l) A

Hormones in mammals

A work independently of the nervous system.

B co-ordinate bodily activities.

C are produced in minute quantities.

D effect a response only in particular cells.

12h-9 – An 3 (l) D

Insulin, released by cells of the pancreas, allows circulating glucose to enter cells by bonding with receptors on the cell membrane and this triggers off the mechanism for glucose transport across membranes.

High levels of glucose in the blood could result from

A destruction of the pancreatic cells that produce the hormone.

B inactivation of insulin by antibodies in the bloodstream.

C a decrease in the number of insulin receptors on peripheral cells.

D increased metabolism of glucose within the target cells.

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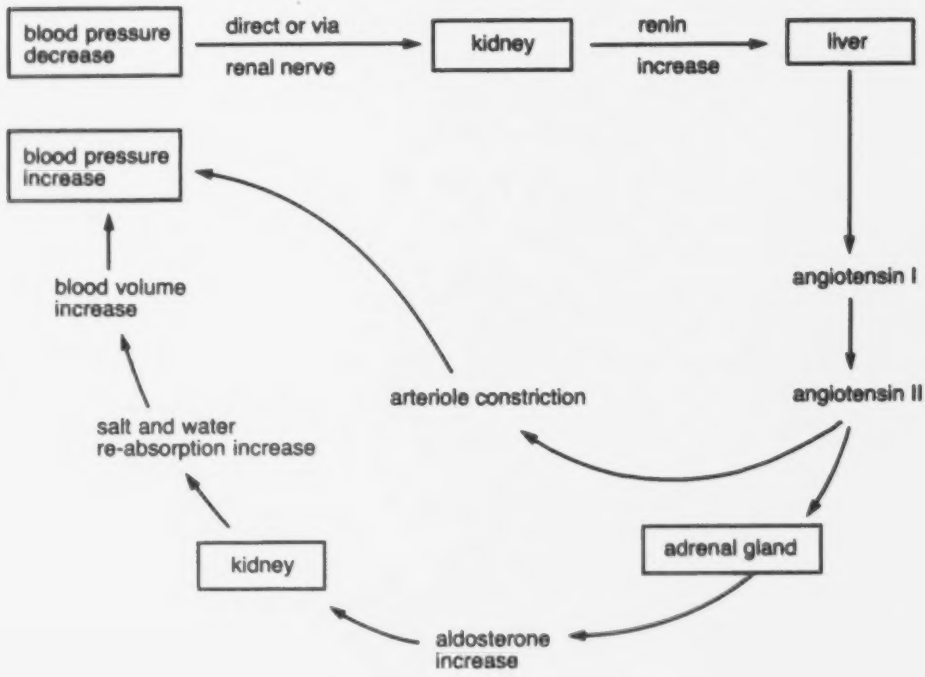
12h-10 – An 4 (I) B **Blood pressure is determined by two basic elements; the total volume of blood and the resistance of the arteries and arterioles to the flow of blood. If either the volume of blood or the arterial resistance increases, blood pressure rises. Blood volume and arterial resistance are controlled in part by the enzyme renin. When the blood pressure drops the kidney responds by secreting renin into the blood stream. This begins a series of reactions that ultimately brings the pressure back to normal, as shown below.**



Hypertension, (permanent high blood pressure) could be caused by

A over-secretion of aldosterone due to a tumour of the adrenal gland.
B obstruction of blood flow to the kidneys.
C increased production of angiotensinogen by the liver.
D failure of the kidneys to excrete excess salt in persons with a high dietary intake of salt.

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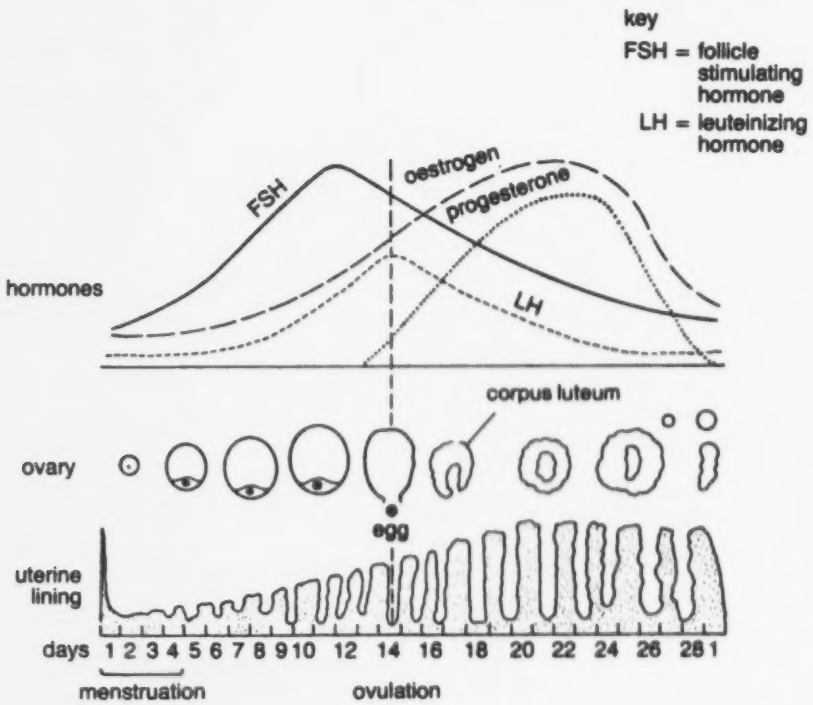
The next 2 items refer to the following information:

The following diagram and graphs illustrate the interrelationships between blood hormone concentration, ovulation and structure of the uterine lining during the human menstrual cycle.



12h-11 Each of the following deductions is reasonable from the data.

–
Co
3
(I)
C

A The rising level of LH (Luteinizing hormone) stimulates ovulation.

B Progesterone is produced by the corpus luteum and inhibits the release of LH.

C FSH (Follicle-stimulating hormone) inhibits the release of oestrogen.

D FSH, LH and progesterone are involved in negative feedback systems.

12h-12 After about the age of 45 a woman's menstrual cycle may become irregular and sooner or later cease. This is called menopause. Oestrogen and progesterone are no longer produced.

–
An
5
(I)
D

Each of the following deductions is reasonable.

A The lining of the uterus could not be maintained.

B The release of FSH (Follicle-stimulating hormone) could increase since its production is no longer inhibited by progesterone.

C Low oestrogen level is due to lack of development of the ovary.

D The release of LH (Luteinizing hormone) would be inhibited.

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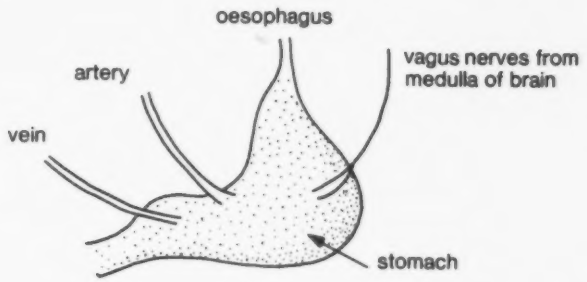
The next 2 items refer to the following information:

The stomach is known to release acid during the digestive process. Investigations into the control of this acid secretion have been carried out by manipulating the blood flow and nervous input to the stomach (see diagram).



Experiments have shown that

I The sight and smell of food induces acid secretion in the stomach, even before food reaches the stomach. The response is blocked by cutting the vagus nerve.

II Adding food chemicals into the stomach promotes acid release. This response is stopped by blocking the vein, but not by anaesthetising the stomach.

III Physical distension of the stomach wall increases acid secretion, even when the vagus has been cut. Blocking the vein does not eliminate this response.

IV Physical distention of the stomach wall causes a small increase in gastric secretion when the vein is blocked. However, this response is inhibited when anaesthetic is applied to the stomach.

12h-13 The above data support the following hypotheses concerning the control of acid secretion.

12b An 5 (I) C

A There are receptors sensitive to stretch within the stomach.

B There is a hormone released by the stomach that promotes acid secretion.

C There is secretory tissue within the stomach directly sensitive to food chemicals.

D There is a neural pathway within the stomach wall that activates acid secretion.

12h-14 The following stimulus—response models are consistent with the observations I—IV above.

17c An 5 (I) B

A stimulus–receptor —nerves→ central nervous system —nerves→ response in I

B stimulus–receptor —nerves→ gland —hormone→ response in II

C stimulus–receptor —nerves→ response in III

D stimulus–receptor —nerves→ gland —hormone→ response in IV

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13 CELLULAR PROCESSES

Activities within Cells

13a—Cell chemical composition and basic requirements

CORRECT response items

13a-1 – Co 2 (c) C

The concentration of some ions and molecules within a cell may be different from the concentration of these ions and molecules in the external environment of the cell.

This difference in concentration is maintained directly by the activities of the

A mitochondria.
B nucleus.
C cell membrane.
D plastids.

The next 2 items refer to the following information:

When validating reagents to be used in testing for chemical components of cells, most students in a class obtained the following colour changes in the test materials.

	Staining reactions				
Material	Benedict's solution	I_2-KI	I_2-KI H_2SO_4	Sakaguchi test	Aniline sulfate
Simple sugar	orange	–	–	–	–
Starch	–	blue/black	–	–	–
Cellulose	–	–	deep blue	–	–
Protein	–	–	–	yellow	–
Fat	–	–	–	–	–
Lignin	–	–	–	–	yellow
Water	–	–	–	–	–

Note: Sakaguchi Test—sodium hydroxide + α—naphthol solution + sodium hypochlorite

13a-2 17g Co 3 (c) B

One student obtained a colour change to yellow–orange when starch was tested with Benedict's solution.

Which one of the following is the most likely explanation for this result?

A The student used the wrong reagent solution.
B The starch had been contaminated with simple sugar.
C Starch is a polysaccharide composed of simple sugar units.
D Too much Benedict's solution was used in the test.

13a-3 17d Co 2 (c) C

Many students thought it was a waste of time to use water as there was no reaction with water in any of the tests.

The best answer to this criticism is that

A as water is present in all cells it must be used in the tests.
B water acts as a catalyst in these reactions.
C the tests with water showed that colour changes did not occur in the reagents in the absence of the test material.
D water is necessary to provide a medium in which reactions can occur.

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INCORRECT response items

13a-4 All single-celled organisms
–
Kn
3
(I)
A

A synthesize sugars.
B respire.
C excrete.
D synthesize protein.

13a-5 A plant's rate of photosynthesis may be determined by measuring
10b
Co
5
(I)
B

A the rate of carbon dioxide uptake.
B the increase in the dry weight of leaves during a given period.
C the rate of evolution of oxygen gas.
D the amount of red and blue light absorbed by the leaves.

13b—Cell respiration

CORRECT response items

13b-1 If liver cells growing in a culture solution were suddenly deprived of oxygen, they would
–
Kn
1
(c)
B

A produce alcohol.
B produce lactic acid.
C accumulate urea.
D accumulate glucose.

13b-2 Which of the following equations represents the conversion of a common storage compound in a potato plant to a substance available for cellular respiration?
13c
Kn
1
(c)
B

A polyphosphate + water $\xrightarrow{\text{phosphatase}}$ triphosphates

B polysaccharide + water $\xrightarrow{\text{amylase}}$ monosaccharides

C polynucleotide + water $\xrightarrow{\text{ribonuclease}}$ nucleotides

D polypeptide + water $\xrightarrow{\text{peptidase}}$ amino acids

13b-3 ATP (adenosine triphosphate) is essential to every living cell because it
–
Kn
3
(c)
C

A forms energy from glucose and ADP (adenosine diphosphate).
B speeds up digestion of carbohydrates.
C stores energy in a form that is instantly available.
D stores energy released during the breakdown of ADP.

13b-4 When yeast cells undergo fermentation or anaerobic respiration the products are
–
Kn
3
(c)
C

A carbon dioxide and water.
B lactic acid and water.
C carbon dioxide and ethanol.
D glucose and oxygen.

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13b-5 The following table shows a comparison between aerobic respiration and anaerobic respiration.

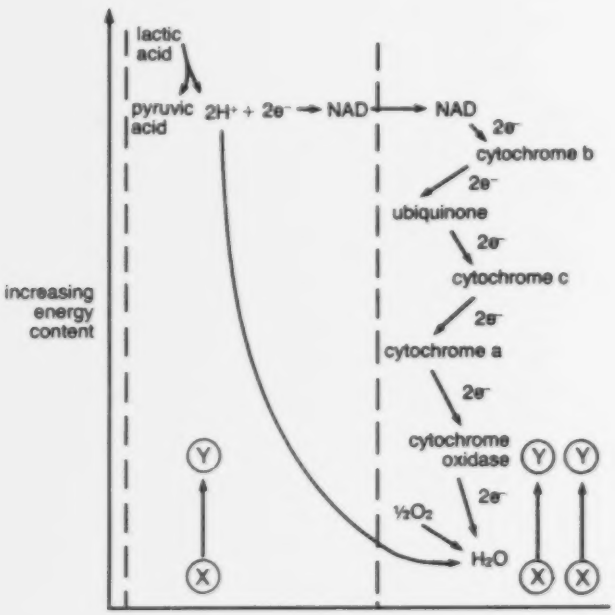
–
Kn
3
(c)
D

Select the **incorrect** comparison.

	Aerobic respiration	*Anaerobic respiration*
A	forms more adenosine triphosphate molecules per glucose molecule respired	forms fewer adenosine triphosphate molecules per glucose molecule respired
B	releases more energy for use by the cell	releases less energy for use by the cell
C	occurs at higher concentrations of oxygen	occurs in the absence of oxygen or at lower concentrations of oxygen
D	forms final products having higher chemical energy	forms final products having lower chemical energy

13b-6 The diagram below shows the changes which take place during a process which occurs in the muscles of mammals when they are recovering from heavy exertion. The diagram is specifically designed to show changes in energy level of the compounds involved; the higher a compound appears on the diagram the higher its energy content.

13g
Co
4
(c)
A



The reaction X ⟶ Y is most likely

A	ADP	⟶	ATP
B	glycogen	⟶	glucose
C	water	⟶	cytochrome oxidase
D	glucose	⟶	water + carbon dioxide

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13b-7 More energy is made available in aerobic than anaerobic respiration because

– Co 4 (c) C

A oxygen from the air supplies some energy.

B aerobic respiration is an energy-releasing reaction, whereas anaerobic respiration is a reaction requiring energy.

C alcohol produced in anaerobic respiration contains chemical energy which may be released by a further reaction.

D more energy is lost as heat in an anaerobic reaction.

13b-8 A mass of living cells was placed in a culture medium under aerobic conditions. The cells were supplied with glucose labelled with radioactive carbon-14.

– Ap 3 (c) A

Which one of the following would probably be true?

A Some carbon dioxide subsequently produced by the cells would contain carbon-14 atoms.

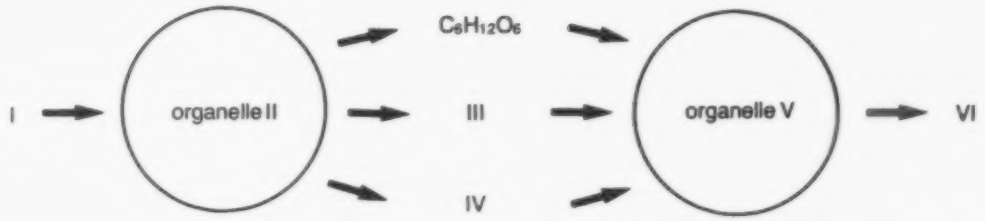
B Some of the carbon-14 atoms would initially appear in ATP molecules.

C Some radioactivity would be transferred to the water molecules produced by respiration.

D Additional heat from radioactivity would reduce enzyme activity.

The next 2 items refer to the following information:

The diagram illustrates some of the relationships existing between two cell organelles.



13b-9 It is reasonable to identify II, III, IV, V, and VI as

13d An 3 (c) C *

	II	III	IV	V	VI
A	mitochondria	CO_2	O_2	chloroplast	ATP
B	mitochondria	O_2	CO_2	chloroplast	ATP
C	chloroplast	O_2	CO_2	mitochrondria	ATP
D	chloroplast	O_2	CO_2	mitochrondria	ADP

13b-10 I most likely represents

13e Ap 2 (c) A

A light.

B heat.

C enzymes.

D glucose.

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13b-11 The solvent properties of water are very important in living systems because

13a
Co
2
(c)
B

A water molecules with larger molecules attached to them can readily penetrate cell membranes.

B substances dissolved in water exist as separate ions or molecules which can readily take part in chemical reactions.

C many hydrogen and oxygen ions are formed when water ionizes.

D water molecules increase their motion as the temperature rises.

13b-12 Two proteins, actin and myosin, are the major protein components of muscle tissue. When cellular extracts containing these proteins are mixed together in the presence of mineral ions outside the body of a living organism, they can be made to contract. However this occurs only if a particular compound is present.

–
Co
2
(c)
A

This compound is

A ATP (adenosine triphosphate).

B ADP (adenosine diphosphate).

C NAD (nicotinamide adenine dinucleotide).

D lactic acid.

INCORRECT response items

13b-13 Each of the following biological activities is an energy-yielding reaction.

–
Kn
2
(I)
D

A $\text{ATP} \xrightarrow{\text{enzyme}} \text{ADP} + \text{phosphate}$

B $\text{glucose} + \text{oxygen} \xrightarrow{\text{enzymes}} \text{carbon dioxide} + \text{water}$

C $\text{glucose} \xrightarrow{\text{enzymes}} \text{ethyl alcohol} + \text{carbon dioxide}$

D $\text{glucose} \xrightarrow{\text{enzymes}} \text{starch}$

13b-14 The following reactions are exergonic.

–
Co
2
(I)
C

A glucose ⟶ alcohol + carbon dioxide

B lactic acid ⟶ carbon dioxide + water

C carbon dioxide + water ⟶ glucose

D protein ⟶ amino acids

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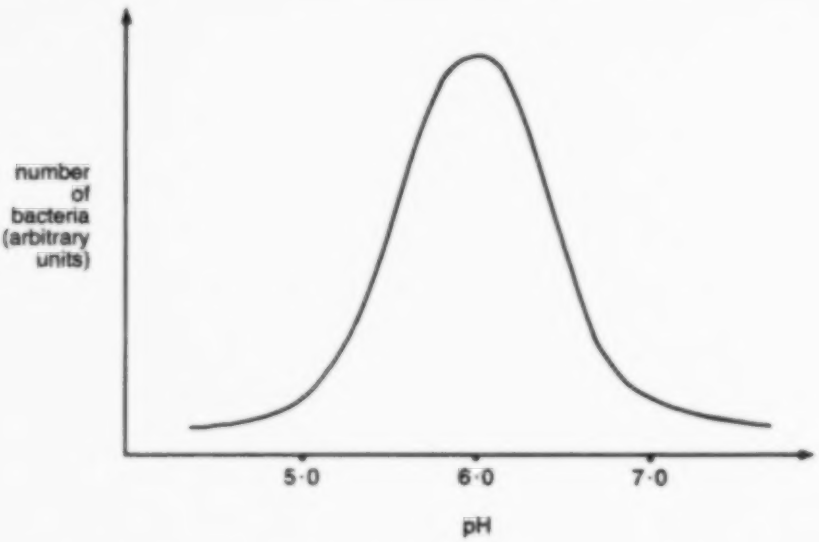
13b-15 The following graph shows the relationship between pH and the number of bacteria causing putrefaction of meat.

– Co 3 (i) A



After the death of an animal, the glycogen present within muscle cells is converted to lactic acid.

glycogen ⟶ lactic acid

The pH of the muscle in a live animal is approximately 7.

It would be reasonable to conclude that

A aerobic respiration takes place in the muscles of the animal after death.
B meat at pH = 6 will putrefy more quickly than meat at pH = 5.
C the higher the glycogen level in the muscles at death the lower the pH of the meat will become.
D lactic acid is not present in high concentrations in living muscles.

13b-16 The following physiological processes require energy derived from cellular respiration.

– Co 3 (i) B

A involuntary peristaltic movements in the intestine of a hungry person
B movement of carbon dioxide across the alveolar wall of an athlete
C movement of substances up a tree within phloem tissue
D reabsorption of glucose from kidney tubules into blood capillaries

13c—Enzymes

CORRECT response items

13c-1 When some living cells were heated to 60 °C, their biological activities stopped.

– Co 1 (c) B

Which one of the following is the most probable cause of this?

A the breakdown of the cell's walls
B the inactivation of the cell's enzymes
C the hydrolysis of the cellular carbohydrates
D the denaturation of the fats within the cell

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13c-2 – Co 2 (c) D

Phosphatase is an enzyme which will release phosphate groups from certain substrates. When phenylphosphate is acted on by phosphatase, phenol is formed and its presence can be detected by a colour reaction. A student used this test to look for phosphatase in a variety of substances. Reactions obtained included the following:

Material	Whole	Ground	Boiled
Liver	+	++	–
Milk	++	NT	–
Bacterium A	+	++	–
Bacterium B	–	–	NT

++ strong reaction
+ weak reaction
– no reaction
NT not tested

No reaction occurred with any of the substances after the material had been boiled.

The most probable reason for this is that

A only living tissues contain the enzyme.
B boiling increases the activity of the enzyme.
C boiling breaks down the phenylphosphate before the enzyme can act on it.
D the enzyme is denatured by boiling since it is a protein.

13c-3 13a Co 3 (c) B

Groups of compounds capable of catalysing the breakdown of cell compounds are present within most living cells. However these compounds do not normally destroy the cell itself.

This can be explained by the fact that they

A act only on proteins not found in the cell.
B are localized within organelles.
C become chemically active only when the cell is old or dead.
D carry out other activities in the living cells.

13c-4 – Ap 2 (c) B

An inexperienced cook attempted to make pawpaw jelly out of sweetened raw fruit pulp and gelatin. After 8 hours in a refrigerator the jelly was still liquid. A biochemist explained that pawpaw contains an enzyme which acts on gelatin, a protein which causes jellies to 'set'.

The cook applied her knowledge of biology to the problem.

Her next attempt at 'setting' pawpaw jelly would be more successful if she

A added more raw pawpaw pulp to the recipe.
B cooked the pawpaw pulp before adding the gelatin.
C added more gelatin to the raw pawpaw pulp.
D set the refrigerator at a colder temperature.

13c-5 – Ap 3 (c) A

Junket is a food prepared by adding a solution of rennin, a protein-digesting enzyme, to warm milk.

The preparation of junket illustrates that enzymes are able to

A function effectively outside living organisms.
B act on a particular substance.
C function effectively only at a specific temperature.
D act in processes not concerned with digestion.

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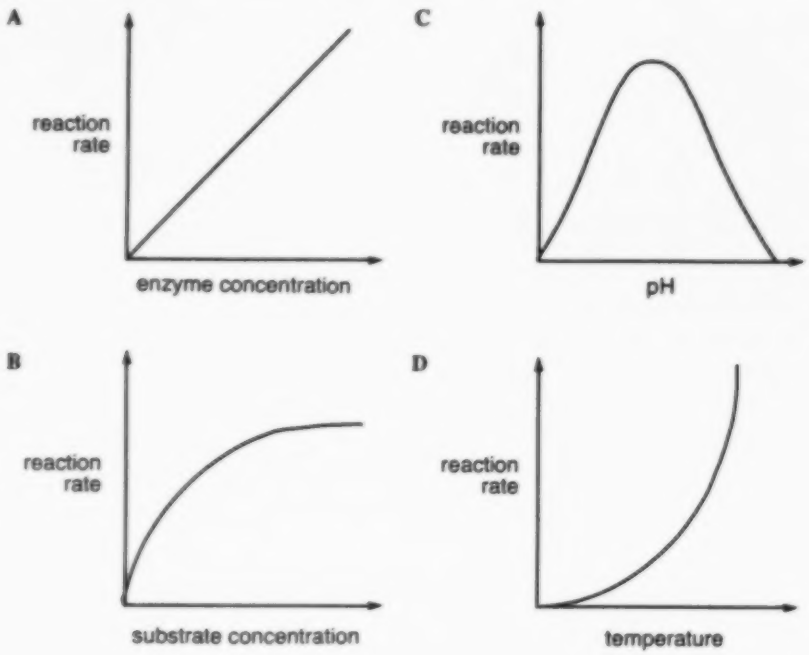
INCORRECT response items

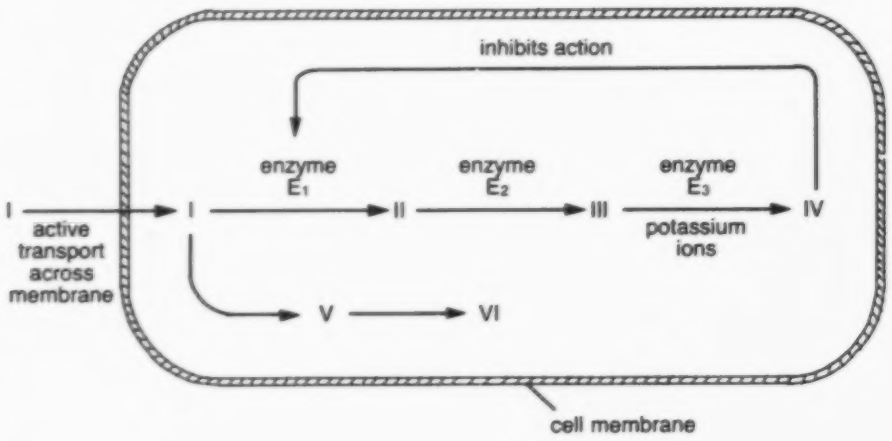
13c-6 – Co 3 (I) D

A study was being made of the factors that affect the rate of a particular enzyme reaction. A variety of data was collected and expressed in a graphical form. In each graph the vertical axis represents the rate of the reaction.

You could reasonably expect each of the following results.



The next 2 items refer to the following diagram. It outlines a sequence of biochemical reactions in an animal cell.



Assume that this series of reactions is independent of other reactions occurring in the cell.

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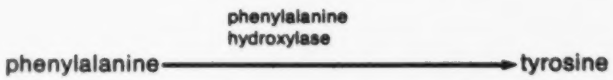
13c-7 13g Co 2 (I) C An animal cell such as the one illustrated above is incubated in a medium containing compound I. In order to convert compound I into compound IV the following compounds would be required within the cell.

A ATP
B enzyme E_2
C compound III
D potassium ions

13c-8 13g Ap 3 (I) A You would reasonably expect

A a continuous production of a constant amount of compound VI in a cell metabolising under optimal conditions.
B an increase in the production of compound VI if the cell is deficient in enzyme E_1.
C an accumulation of compound II if the cell is deficient in enzyme E_2.
D that a period of production of IV would be followed by a period in which IV was not produced and so on.

13c-9 – Ap 2 (I) C Phenylalanine hydroxylase, an enzyme isolated from human cells, catalyses the following reaction.



In this reaction

A the rate of production of tyrosine can depend on the amount of phenylalanine hydroxylase present.
B the maximum amount of tyrosine produced will depend on the amount of phenylalanine initially present.
C the maximum amount of tyrosine produced will depend on the amount of phenylalanine hydroxylase present.
D it would be expected that the rate of production of tyrosine from a given amount of phenylalanine would be greater at 37 °C than at 5 °C if the same amount of phenylalanine hydroxylase were present.

13d—Photosynthesis as a chemical process

CORRECT response items

13d-1 17d An 2 (c) C An isotope of oxygen ^{18}O, (normal oxygen is ^{16}O), was used by scientists to find out whether the oxygen released in photosynthesis came from water or from carbon dioxide.

Which of the following, if true, would support the hypothesis that the oxygen comes from the water?

A When normal water and carbon dioxide with ^{18}O were used in photosynthesis, all the oxygen released was the ^{18}O isotope.
B When normal water and carbon dioxide with ^{18}O were used in photosynthesis, some oxygen released was ^{18}O and some ^{16}O.
C When normal carbon dioxide and water with ^{18}O were used in photosynthesis, all the oxygen released was the ^{18}O isotope.
D When normal carbon dioxide and water with ^{16}O were used in photosynthesis, all the oxygen released was the normal ^{16}O isotope.

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INCORRECT response items

13d-2
13g
Kn
5
(I)
A

The overall reaction occurring in photosynthesis can be written as follows:

$$CO_2 + 2H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} CH_2O + H_2O + O_2$$

The changes which occur in this reaction include

- A carbon dioxide molecules combining with water molecules to form carbohydrate.
- B the formation of molecular oxygen from water.
- C one water molecule being incorporated into the carbohydrate.
- D oxygen atoms being derived from carbon dioxide and included in the carbohydrate.

13d-3
–
Ap
2
(I)
D

A biologist investigating the nature of chloroplasts completely removed whole chloroplasts from the rest of the cell, and kept them functioning by suspending them in a particular solution.

He placed this suspension of chloroplasts in the light, and tested for gas exchange between the chloroplasts and the solution and also for sugar production by the chloroplasts.

After one hour, he placed the suspension in the dark, left it for some time, and then repeated his tests.

If any of the following occurred, they would support the hypothesis that photosynthesis, but not respiration, takes place in the chloroplasts.

- A In the light, the chloroplasts gave off oxygen and removed carbon dioxide from the suspension.
- B In the dark, following the light period, the chloroplasts neither gave off nor took up oxygen or carbon dioxide.
- C After being in the light for 10 minutes, sugar became evident in the suspension.
- D In the dark, following the light period, any sugar in the suspension disappeared.

Cell Ultrastructure and Function

13e—Cell organelles and chemical processes

CORRECT response items

13e-1
9c
Co
1
(c)
B

Mammalian sperm cells expend a large amount of energy in moving through the female reproductive tract.

On the basis of this information you would predict that these cells would contain a large number of

- A vacuoles.
- B mitochondria.
- C ribosomes.
- D chloroplasts.

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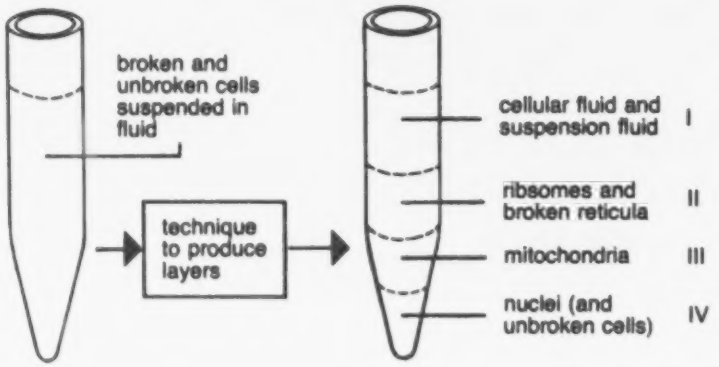
The next 2 items refer to the following diagram:



13e-2 17g Co 1 (c) C *

The biological technique that can be used to concentrate cellular organelles into layers or fractions, as shown in the diagram, is called

A defraction.
B suspension.
C centrifugation.
D dialysis.

13e-3 17g Ap 2 (c) D *

The fraction with the highest concentration of DNA would be

A I.
B II.
C III.
D IV.

INCORRECT response items

13e-4 13g Kn 2 (i) A

Each of the following is a necessary factor in the process of photosynthesis in higher plants.

A nucleus
B chloroplast
C specific enzymes
D carbon dioxide

13e-5 – Kn 2 (i) B

Recent studies of cell structure and function have revealed that cell activities are restricted to particular organelles in the cell.

The following organelles and cell activities appear to be closely associated.

A the mitochondria and aerobic respiration
B the ribosomes and production of RNA
C the nucleus and production of DNA
D chloroplasts and the production of glucose

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13e-6 The Golgi apparatus

–
Kn
4
(I)
C

A produces secretory products of the cell.
B is involved in synthesis of some cell components.
C is formed by an infolding of the cell membrane.
D takes part in plant cell wall synthesis.

13f—Membranes as dynamic structures

CORRECT response items

13f-1 Active transport occurs when substances move across membranes

–
Co
1
(c)
A
*

A from lower to higher concentrations.
B from higher to lower concentrations.
C by osmosis.
D by simple diffusion.

The next 2 items refer to the following information:

Two compartments, I and II, are separated by a semi-permeable membrane. The volume of each compartment is 2 mL. Concentrations of substances in each compartment are expressed as parts per million (ppm).

	I		II
K^+	3.5 ppm (as KC1)	K^+	30.0 ppm (as KC1)
Na^+	20.0 ppm (as NaC1)	Na^+	25.0 ppm (as NaC1)
Hexose	30.0 ppm	Hexose	30.0 ppm

Semi-permeable membrane
(permeable to Na^+ and K^+)

13f-2 The movement of Na^+ ions

10b
Co
2
(c)
C
*

A is from I to II only.
B is from II to I only.
C occurs in both directions.
D does not occur in either direction.

13f-3 If the system was analysed after equilibrium had been reached, what would be the concentration of Na^+ ions in II?

10b
Ap
2
(c)
B
*

A 20 ppm
B 22.5 ppm
C 25 ppm
D 35 ppm

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INCORRECT response items

13f-4 The internal membranes which can be identified in living cells

– Kn 1 (i) D

A are more frequent and complex in eukaryotic cells than prokaryotic cells.
B have different permeabilities to different substances.
C have been found to consist of proteins and lipids.
D provide for a one-way movement of substances into the organelle.

13f-5 The following are features of the cell membrane.

– Kn 2 (i) D

A It is differentially permeable to molecules and ions.
B It is similar in composition to other membranes within the cell.
C It forms the outermost boundary of the cytoplasm.
D It has pores to allow for the expulsion of disused cell components.

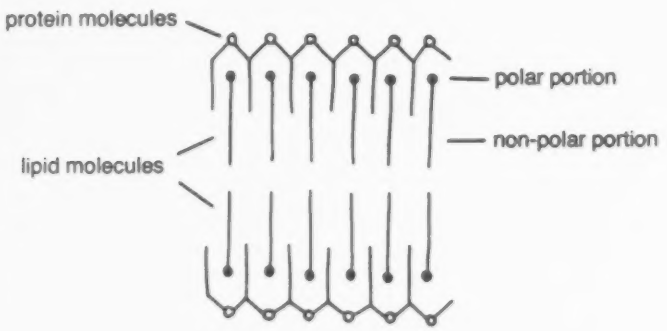
13f-6 When comparing endocytosis and exocytosis, it is true to say that

– Co 2 (i) A

A endocytosis expends ATP whereas exocytosis is a passive process.
B endocytosis brings substances in from outside the cell, whereas exocytosis expels substances from within the cell.
C the Golgi apparatus is involved with both endocytosis and exocytosis.
D liquids can be transported in both endocytosis and exocytosis.

13f-7 Danielli and Davson were pioneers of cell biology. They hypothesized a membrane structure as follows.

– Ap 4 (i) D



Their model satisfactorily explains each of the following properties of cell membranes.

A The permeability of membranes is influenced by detergents.
B The rate at which substances pass through a membrane is related to their solubility in lipids.
C Small non-polar molecules such as ethene move quickly across a membrane.
D Water molecules have the highest rate of movement across membranes.

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Molecular Interactions

13g—Chemical reactions in cells, and their control

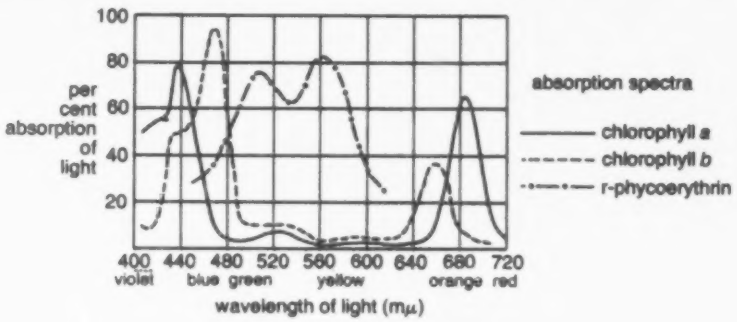
CORRECT response items

The next 3 items refer to the following information:

Information regarding the role of a pigment in photosynthesis can be obtained by plotting the absorption spectrum and the action spectrum on the same graph. The *absorption spectrum* shows the percentage absorption of light plotted against wavelength. The *action spectrum* shows the rate of photosynthesis at different wavelengths.

Figure 1 shows the absorption spectra of three photosynthetic pigments.

Figure 1



Figures 2 and 3 show absorption and action spectra of two algae—one green and one red.

Figure 2

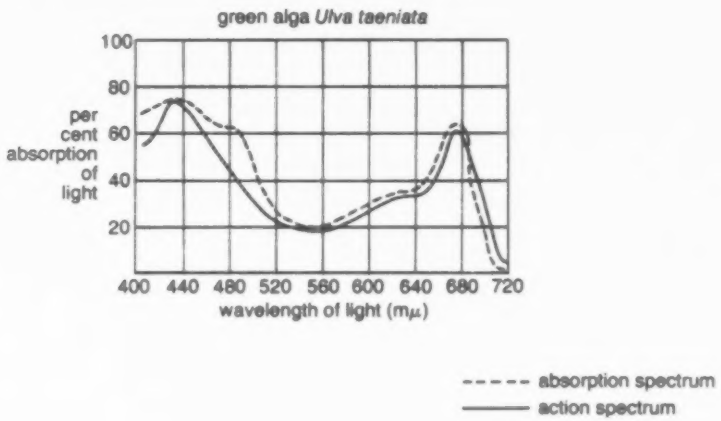
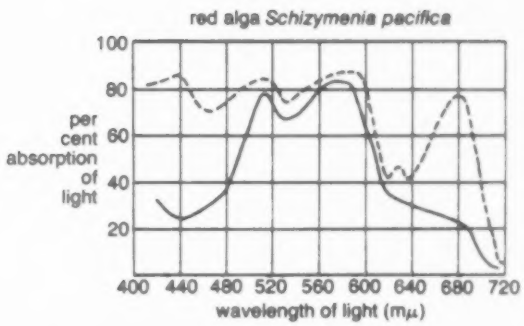


Figure 3



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13g-1 What pigment/s appear/s to be most important in photosynthesis in *Ulva taeniata*?

10b
Ap
3
(c)
C
*

A chlorophyll *a*
B r-phycoerythrin
C chlorophylls *a* and *b*
D chlorophyll *b* and r-phycoerythrin

13g-2 An examination of the absorption spectrum of r-phycoerythrin indicates that the colour of the pigment would be

10b
Ap
4
(c)
D
*

A green.
B yellow.
C light green, i.e. a mixture of green and yellow wavelengths.
D purple, i.e. a mixture of violet and orange-red wavelengths.

13g-3 Which one of the following best explains the adaptive advantage of a number of different pigments in the plant kingdom?

15d
An
3
(c)
C
*

A Different plants transmit different wavelengths and so appear to be different colours.
B Different pigments increase the rate of respiration by having the pigment electrons excited at different wavelengths.
C Different pigments absorb different wavelengths and thus different plants can utilize a number of wavelengths in photosynthesis.
D The chance of survival of plants in different environments is increased since different pigments transmit harmful radiation.

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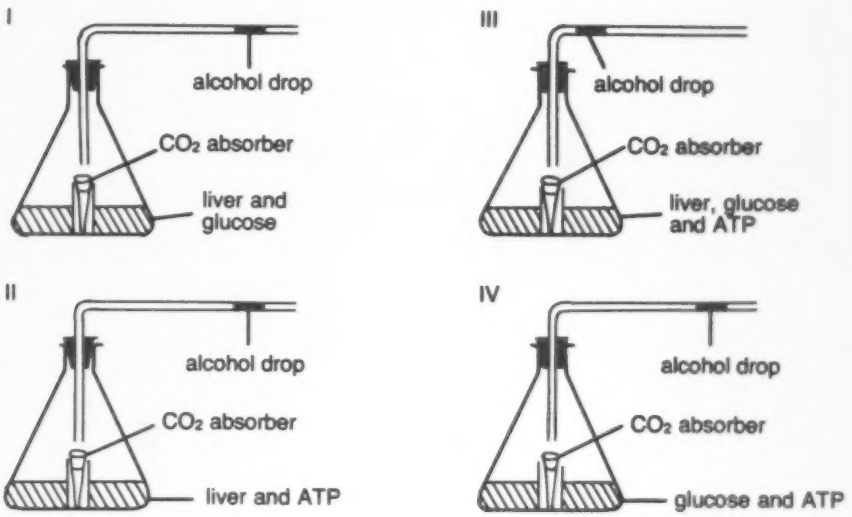
The next 3 items refer to the following information:

In an experiment, equal amounts of ground up liver cells, with the ATP removed, are placed in respirometers I, II and III. Flask I contains glucose. ATP is added to flask II. Flask III contains a glucose solution and ATP. Flask IV contains no liver—only glucose and ATP. All flasks are placed in a water bath at 20 °C. The following figures represent the respirometers after one hour.



13g-4 Which is the best interpretation from these data?

An 1 (c) B *

A ATP and glucose interact to produce CO_2.
B ATP is necessary to start the respiratory breakdown of glucose.
C respiration cannot take place outside of living cells.
D glycolysis is not operating since no ATP is given off.

13g-5 Which of the following gives the correct purpose of the flasks indicated?

An 4 (c) A *

	Flask	*Purpose*
A	I & II	to determine whether the reaction will occur *without glucose.*
B	II & III	to determine whether the reaction will occur *with ATP.*
C	I & IV	to determine whether the reaction will occur *without ATP.*
D	III & IV	to determine whether the reaction will occur *without liver.*

13g-6 The reaction in flask III stops after two hours.

What is the most likely explanation?

Ap 1 (c) A *

A All the glucose is used up.
B All the ATP is used up.
C All the CO_2 is used up.
D All the liver is used up.

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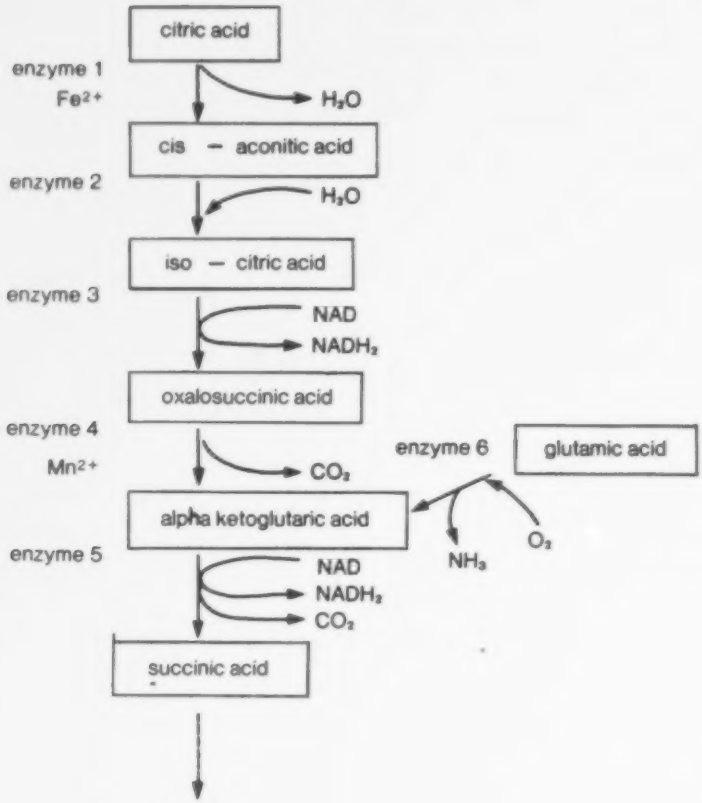
13g-7 – Ap 2 (I) B

The metabolic pathway for the first 5 steps in aerobic respiration is summarized in the diagram below.



From this information the following statements are reasonable.

A Enzymes 1 to 5 are most likely to be found in close proximity in a cell organelle.

B If succinic acid was continually removed from the system this series of 5 reactions would stop.

C In this series of reactions NAD and $NADH_2$ are acting as coenzymes, and Fe^{2+} and Mn^{2+} are cofactors which activate enzymes.

D A low level of citric acid would lead to use of the amino acid glutamic acid in the body metabolism.

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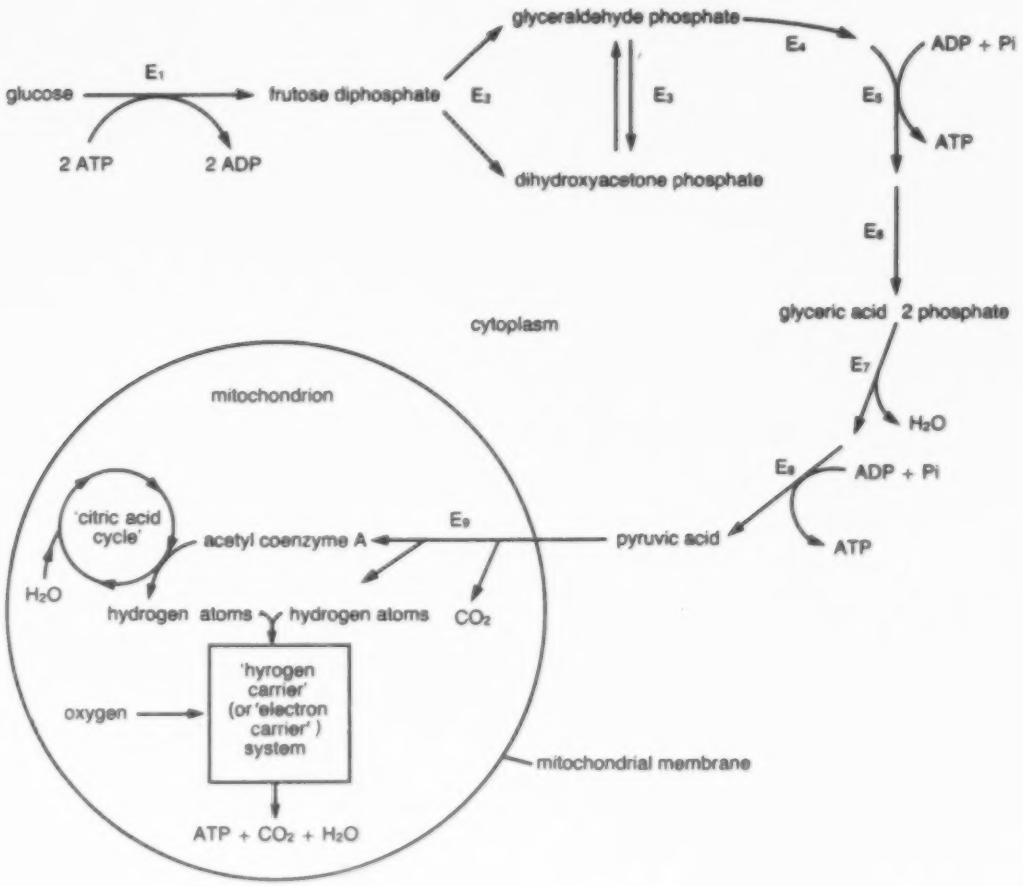
The next 4 items refer to the following information:

The aerobic respiration of glucose in certain mammalian cells involves the following biochemical pathway:

Note: E = Enzyme; P_i = inorganic phosphate



13g-8 To enable this series of reactions to occur, the cell membrane must be permeable to

Co
1
(I)
A

A pyruvic acid.
B carbon dioxide.
C oxygen.
D glucose.

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13g-9 The mitochondrial membrane must be permeable to

–
Co
1
(I)
D

A pyruvic acid.
B carbon dioxide.
C oxygen.
D glucose.

13g-10 The rate at which ATP is produced will depend on

–
Co
2
(I)
B

A the availability of glucose to the cell.
B the permeability of the mitochondrial membrane to hydrogen atoms.
C the concentrations of the enzymes E_1 to E_8 in the cytoplasm.
D the concentrations of ADP (adenosine diphosphate) and inorganic phosphate.

13g-11 When considering the cytoplasmic reactions, each of the following statements is true.

–
Ap
4
(I)
D

A The reaction catalysed by enzyme E_8 is exergonic.
B Fructose diphosphate contains more energy in its molecular bonding than does glucose.
C Enzyme E_7 is catalysing a dehydration reaction.
D The energy released during the breakdown of glyceraldehyde phosphate is accounted for in the production of ATP and pyruvic acid.

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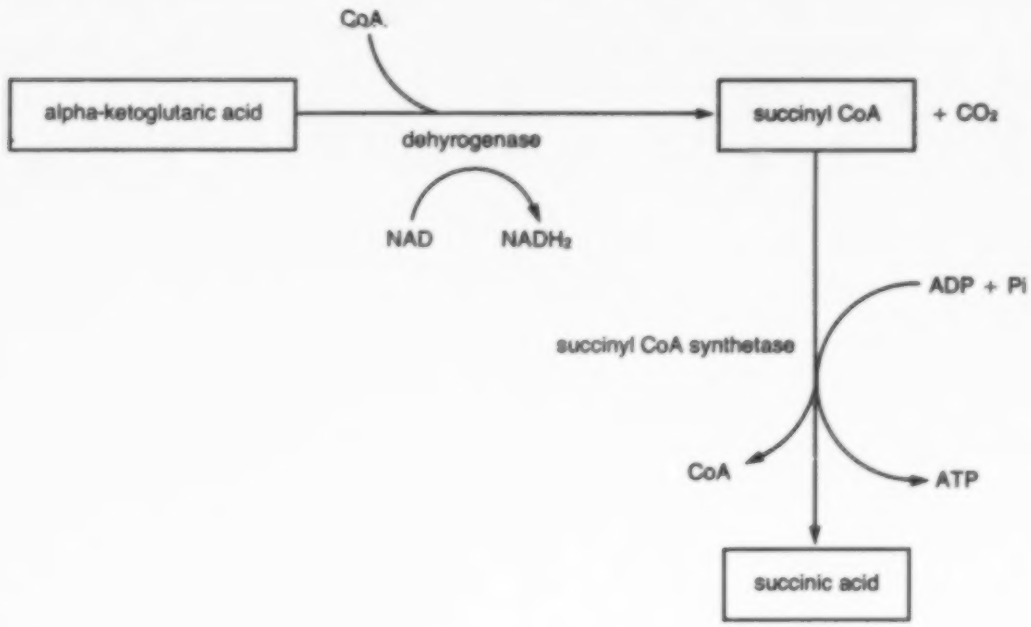
The next 2 items refer to the following information:

Mitochondria can be separated from other cell components by using the ultra-centrifuge and incubating with various substances under controlled conditions. When such mitochondria are exposed to alpha-ketoglutaric acid the following (simplified) reaction sequence occurs.



13g-12 It follows that

–
Ap
2
(i)
D

A NAD and ADP are coenzymes in the conversion of alpha-ketoglutaric acid to succinic acid.

B the conversion of alpha-ketoglutaric acid to succinic acid is exergonic.

C removal of carbon dioxide from the system would promote the conversion of alpha-ketoglutaric acid to succinyl Co-A.

D any decrease in dehydrogenase activity would be followed by an increase in succinyl Co-A synthetase activity.

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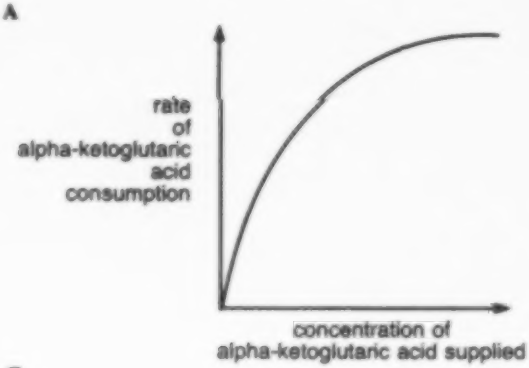
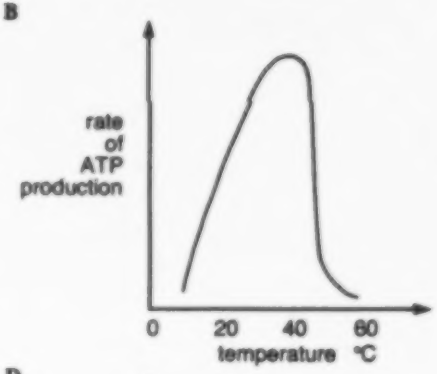
13g-13 It is resonable to assume that the reaction series behaves as indicated in the following graphs.

\-
Ap
3
(i)
C

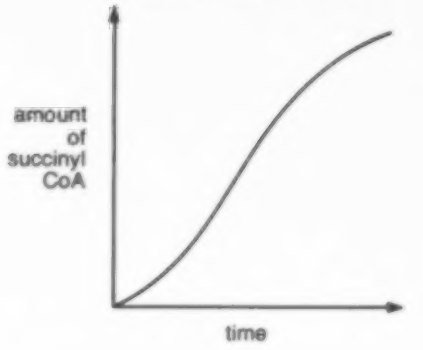
A



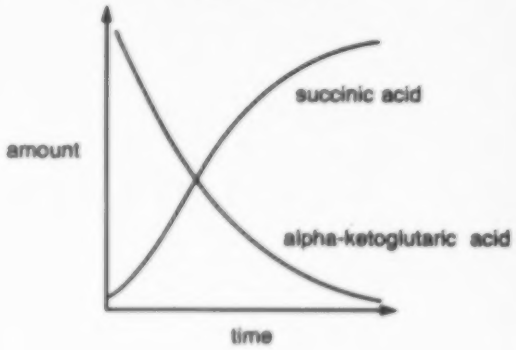
B



C



D



13h—Molecular structure; its effect on chemical and physical processes

CORRECT response items

13h-1 Consider a biological reaction taking place in a test-tube, being catalyzed by an enzyme.

\-
Ap
3
(c)
C
*

If the pH of the solution is adjusted slightly by adding a drop of dilute hydrochloric acid, the reaction may slow down or cease altogether. The addition of a drop of dilute sodium hydroxide solution returns the solution to its original pH, and the reaction resumes at the same rate as before the acid was added.

The most probable explanation for this sequence of events is that

A the enzyme was denatured by the acid.

B the acid hydrolysed some amino acids from the enzyme molecule, but they rejoined the enzyme molecule when the sodium hydroxide was added.

C the bonding in the active site was altered by the pH changes.

D the salt formed by the neutralizing reaction caused the enzyme to crystallize.

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13h-2 Proteins may differ in the pattern of folding and coiling of portions of the protein molecule.
–
Kn
2
(c)
A
•

This is **best** referred to as the molecule's

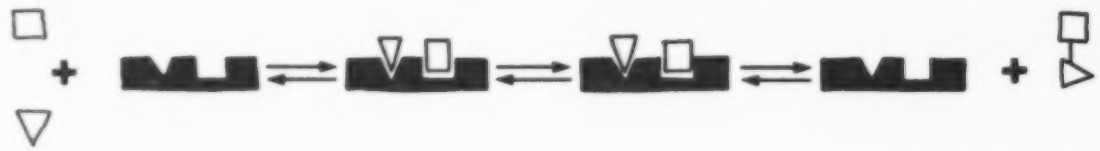
A secondary structure.
B tertiary structure.
C globular configuration.
D amino acid sequence.

INCORRECT response items

13h-3 Factors influencing enzyme activity include
–
Kn
4
(i)
B

A the sequence of amino acids in the active site of the protein molecule.
B the rate at which enzyme molecules are used up during a reaction.
C the level of carbon dioxide in solution.
D the relative difference in concentration between substrate molecules and enzyme molecules.

13h-4 A model for enzyme action can be given as follows.
17c
Co
4
(i)
C



According to this model it would be reasonable to state that

A product molecules are able to recombine with enzyme molecules and block the formation of the enzyme-substrate complex.
B the active sites on an enzyme molecule are specific for certain substrate molecules.
C the rate of conversion of substrate to product equals the rate of re-conversion of product to substrate.
D the synthesis reaction between substrate molecules takes place on the surface of the enzyme molecule.

13h-5 The following series of reactions takes place inside a cell and are catalyzed by enzymes E_1, E_2 and E_3 as indicated.
–
Co
5
(i)
A

$$\text{I} \xrightarrow[E_1]{} \text{II} \xrightarrow[E_2]{} \text{III} \xrightarrow[E_3]{} \text{IV}$$

Factors likely to influence the rate at which III is converted to IV include

A the extent to which the tertiary structure of enzyme E_3 is influenced by changes in the concentration of II.
B relative size differences between the molecules of substrate III and the molecules of enzyme E_3.
C differences in the rates at which enzyme E_2 is able to form III from II and reconvert II from III.
D the extent to which the molecules of product IV are able to inhibit the activity of enzyme E_1.

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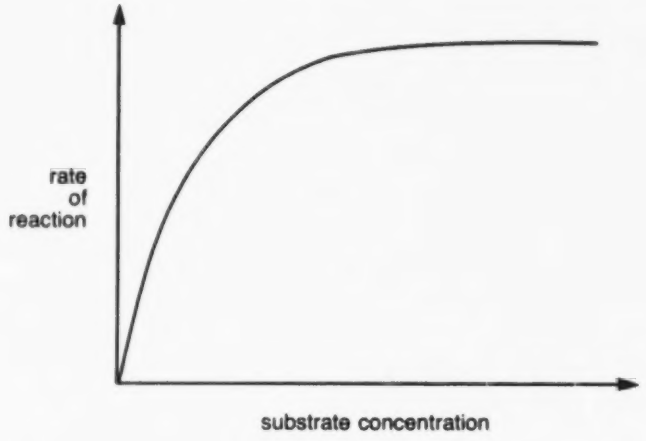
13h-6 – Ap 3 (i) A The graph below illustrates the *in vitro* relationship between substrate concentration and reaction rate for a particular concentration of an enzyme.



The following statements are consistent with the observation that the change in enzyme reaction rate decreases with increasing substrate concentration.

A The enzyme molecules become denatured beyond a particular concentration of substrate.

B The rate of the reverse reaction increases with increasing substrate concentration.

C A concentration exists beyond which the enzyme molecules become saturated with substrate.

D The rate at which product molecules are released by the enzyme decreases with increasing substrate concentration.

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14 HEREDITY

Inheritance as a Phenomenon

14a—Inheritance and environment determine characteristics

CORRECT response items

14a-1
14f
Co
1
(c)
B

The hair of Himalayan rabbits is white except on the extremities (i.e. ears, nose, tail, and feet). The Himalayan rabbit used in the experiment illustrated was homozygous for a gene controlling the synthesis of the black pigment melanin which affects the colour of the extremities.

The hair on the back is normally white but by shaving the skin (I) and applying an ice pack (II) during the period in which the hair regrew it was found that the new hair was black (III).

This evidence suggests that

A areas where the skin is shaved will regrow a different colour.

B the gene for melanin production is expressed phenotypically only where the skin temperature is relatively lower than normal.

C melanin production in the back region cannot be under the control of genes.

D the rabbit could not have been homozygous for a gene controlling the synthesis of melanin.

[illegible]

The next 2 items refer to the following information:

A student was given a potted specimen of each of three distinct colour forms of *Hydrangea macrophylla* var. *macrophylla* bearing rounded heads of sterile flowers surrounded by large bracts. She decided to propagate each plant vegetatively by treating batches of stem tissue to encourage the development of roots. When she had numbers of plants of each colour form she planted one half of the plants individually in pots of alkaline soil and the other half individually in pots of acidic soil. When the plants flowered she recorded the following observations of the colour of the flower heads.

Original plant	Propagated plants in alkaline soil	Propagated plants in acidic soil
white	white	white
pink	pink	blue
blue	pink	blue

14a-2 – An 2 (c) B Which conclusion relating to this variety of plant is **best** supported by the student's observations?

A Asexual reproduction produces highly variable progeny.
B Flower pigmentation is influenced by soil alkalinity and acidity.
C Particular colour forms are poorly adapted to some soils.
D Flower pigmentation is determined by inheritance.

14a-3 – An 2 (c) C Other students in the group then made further statements based on the above results. Which one is **best** supported by the student's observations?

A Sweet perfume in white flowers compensates for the lack of colour in attracting pollinating insects.
B Nocturnal moths are effective pollinators of white flowered forms.
C White flower heads lack pigmentation and so soil acidity and alkalinity do not influence this flower colour.
D Vegetative reproduction ensures progeny lacking variation.

INCORRECT response items

14a-4 – 17k Co 1 (i) B Each of the following observations is consistent with the theory that environmental factors are important in influencing the appearance of characteristics inherited from previous generations.

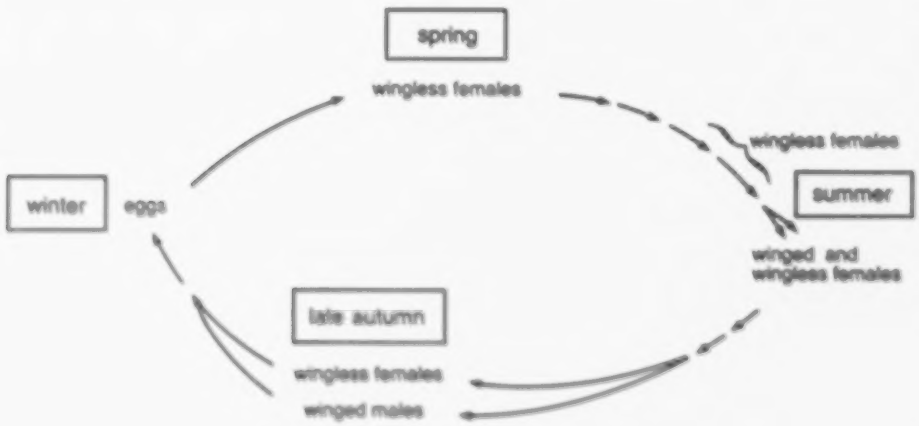
A Trees growing close to the beach often appear more stunted than the same species growing further inland.
B Certain plant species develop identically shaped leaves regardless of the type of soil they are growing in.
C Identical twins separated at birth and raised in different countries may develop different characteristics in their speech.
D Mice from the same litter, when reared separately on different diets, reach different adult weights and sizes.

[illegible]

The next 2 items refer to the following information:

The diagram illustrates the life cycle of the aphid, a small sap-feeding insect. Wingless females hatch in early spring and when mature give birth to female aphids which in turn also produce female offspring.

The population may increase rapidly in summer, and if overcrowding occurs both winged and wingless females may be produced. Winged males are produced in late autumn.



14a-5 14d An 4 (i) A The aphid life cycle shown above supports each of the following statements.

A Sexual reproduction is occurring in summer since both winged and wingless phenotypes are produced.

B A single isolated female is capable of giving rise to a new population of aphids containing both sexes.

C Female aphids give rise to winged males by asexual reproduction.

D Wingless females from the same mother may possess different inheritable characteristics.

14a-6 14d Ap 4 (i) B * From the above information it would be reasonable to state that

A wingless females produced in summer are of the same phenotype as their wingless mothers.

B only female characteristics are inherited from the egg.

C winged males enhance the chances of increased variability within a given population.

D environmental factors influence the appearance in summer of the winged phenotype.

[redacted]

14b—Chromosomes; transfer during life processes, homologous pairs

CORRECT response items

14b-1 – Co 5 (c) C •

Gregor Mendel laid the groundwork of modern genetics through his interpretation of the results obtained in a controlled breeding program using garden peas. Later geneticists have studied patterns of inheritance in organisms such as bacteria, fungi, mice and fruit fly (*Drosophila* sp.).

Which characteristic is lacking in garden peas but present in the second group of organisms listed above making the second group preferred subjects for genetic investigation?

A a large number of detectable differences
B an effective means of combining parental traits in offspring
C a comparatively short life cycle
D a capacity for reproducing numerous offspring

The next 2 items refer to the following information:

In tissue culture, new plants are grown from single cells obtained from a single parent plant. Sugar cane plants produced by tissue culture techniques would be expected to be exact duplicates of the parent plant. However, researchers have found a wide range of resistance to 'eye spot' disease among plants produced from a single tissue culture.

14b-2 14d Ap 3 (c) A

The variation is surprising because

A all the cells in the tissue culture were derived from a single parent cell by mitotic divisions.
B all the plants had been grown under identical conditions in the laboratory.
C all the cells in the tissue culture would have the same number of chromosomes.
D each daughter cell in the culture would contain one of each pair of chromosomes present in the parent.

14b-3 14f Co 3 (c) C •

It is unlikely that gene mutation can account for this variation because

A mutations only occur in reproductive cells.
B mutations only produce harmful characteristics.
C mutation of a particular gene is an extremely rare event.
D the plants are kept under controlled conditions so mutations would not have occurred.

[redacted]

INCORRECT response items

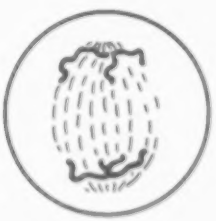
14b-4 – Co 3 (I) B You would expect to see each of the following cells at some stage during the mitotic division of a cell with a diploid number of two.

A

B

C

D



14c—Meiosis and fertilization maintain chromosome sets

CORRECT response items

14c-1 – Co 2 (c) B Which of the following statements **best** describes the role of meiosis in vertebrate reproduction?

A Four daughter cells are produced, therefore increasing the chances of fertilization.
B Haploid gametes ensure the chromosome content is maintained for each generation.
C Meiotic divisions are necessary to eliminate undesirable genotypes.
D Haploid gametes ensure an increase in species diversity in vertebrates.

14c-2 – Co 5 (c) C How many combinations of chromosomes are normally possible in the gametes produced by an organism with three pairs of chromosomes?

A 3
B 6
C 8
D 12

14c-3 – Ap 2 (c) B *Melanoplus differentialis* is a species of grasshopper in which the chromosome number for males is 23 and for females 24.

What number of chromosomes would you normally expect in the gametes of these insects?

	Number of chromosomes	
	ova	*sperm*
A	24	23
B	12	11 or 12
C	12	23
D	24	11 or 12

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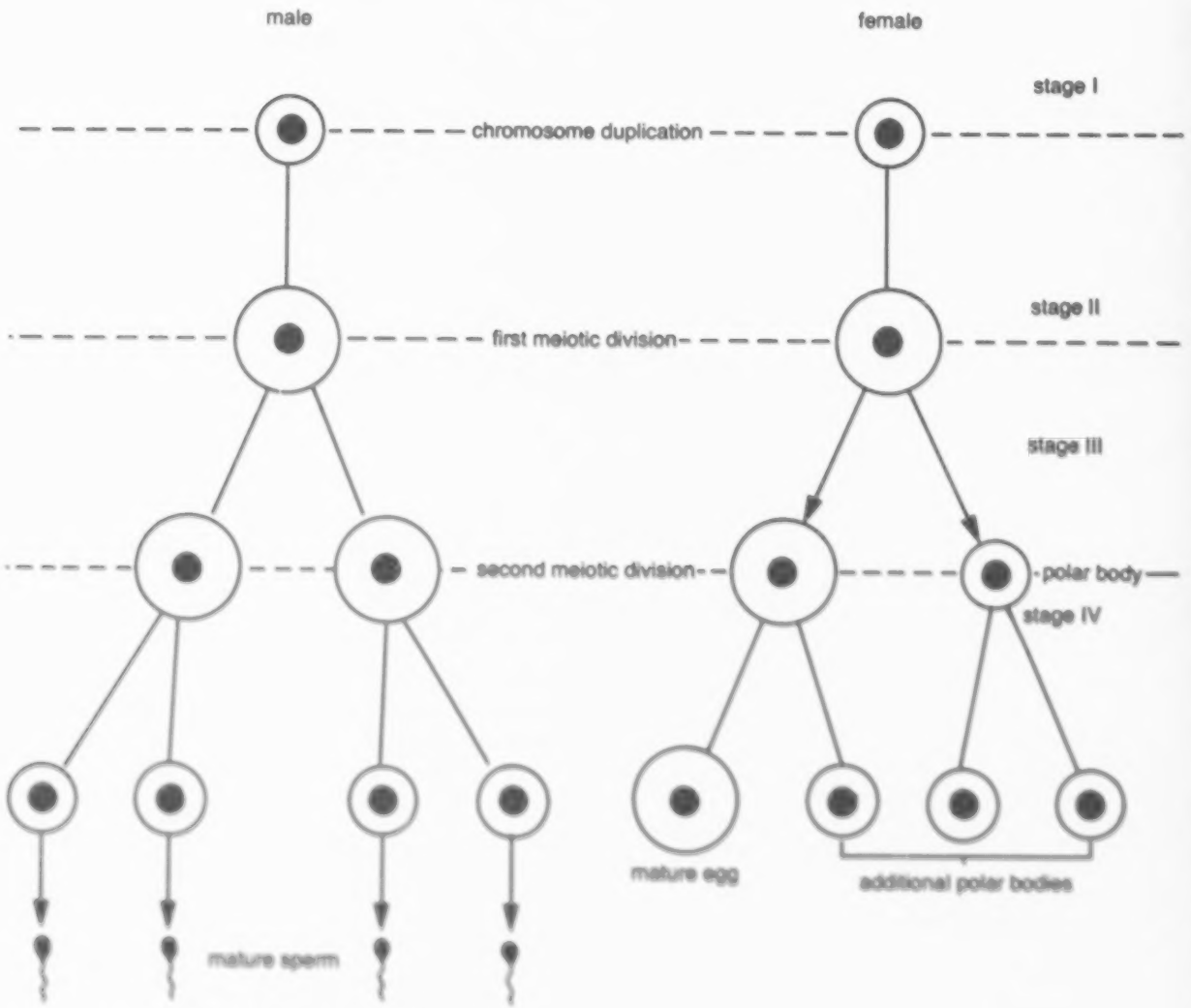
INCORRECT response items

14c-4 – Ap 4 (i) C

The diagrams show the development of mature sperm and eggs through meiosis in the gonads of a mammal. The polar bodies are small degenerate cells containing little, if any, cytoplasm. Most of the cytoplasm remains with the mature egg as a foodstore for the zygote.



From the diagrams, if n is the haploid number

A the polar body at stage III has the same number of chromosomes as the male cells after the first division.

B cells at stage II have four times the amount of DNA as the gamete.

C polar bodies at stage IV have a different number of chromosomes to the polar body at stage III.

D mature sperm and eggs have n chromosomes.

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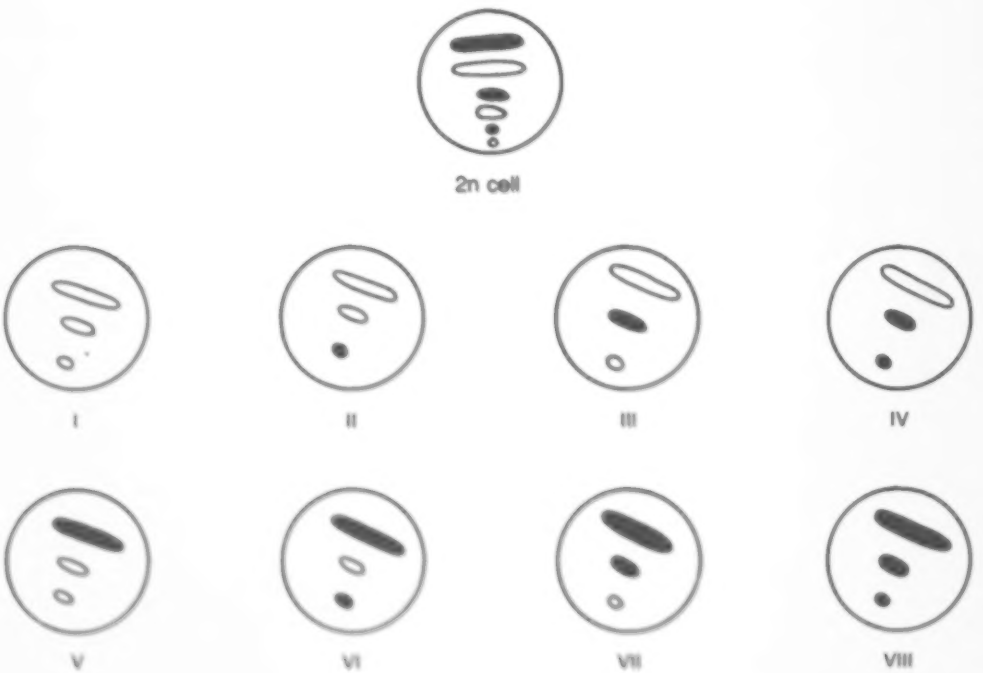
14c-5 – An 4 (I) B The normal mature form of the unicellular aquatic organism *Chlamydomonas* is haploid. The zygote contains 16 chromosomes.

It could be expected that

A the mature cell contains 8 chromosomes.
B mitosis of the mature cell retains 16 chromosomes in each daughter cell.
C during meiosis there are 2 cytoplasmic divisions.
D during meiosis the chromosome number doubles to 32.

14c-6 – An 5 (I) B The chromosome number of the diploid cell in a multi-cellular organism is halved during meiosis (reduction division) to give a haploid cell. As a result of this division, the gamete will contain a single set of chromosomes consisting of paternal and/or maternal chromosomes from a random assortment. The diagram shows the possible paternal–maternal combinations for a haploid number of three. Maternal chromosomes are shaded in the diagram.



If the organism undergoes self-fertilization

A a zygote heterozygous for all characters can be formed by four dierent combinations of gametes.
B a zygote heterozygous for only one character can be formed in eigt ways.
C eny of the gametes could contain chromosomes from one grandparnt only.
D a zygote containing only paternal characters can form.

[redacted]

14d—Sexual reproduction aids variability within the species

CORRECT response items

14d-1 – Co 1 (c) C

Sexually reproducing organisms are more likely to adapt rapidly to changing environments than asexually reproducing organisms.

This is because sexually reproducing organisms

A live in changing environments.
B have short life cycles.
C have variations occurring in their populations.
D have mutations which are lethal.

INCORRECT response items

14d-2 – Kn 1 (i) C

When considering sexual and asexual reproduction it can be said that

A sexual reproduction may involve either internal or external fertilization.
B sexual reproduction requires the union of male and female gametes to form a zygote.
C sexual reproduction is more efficient in that there is less wastage of genetic material by the parents.
D offspring produced asexually show less variability than those produced sexually.

14e—Chromosomes and genes determine inheritance

CORRECT response items

14e-1 – Kn 2 (c) C •

At which of the following stages is the sex of the individual determined?

A when the egg is formed
B when the sperm is formed
C when the zygote is formed
D when the embryo is 16 weeks old

14e-2 – Ap 3 (c) A •

In the grasshopper *Austrovicetes pusilla* the females have 24 chromosomes, two of which are sex chromosomes, but males have 23 chromosomes, only one of which is a sex chromosome.

In this species

A only half the sperm produced by males are capable of fertilizing an egg.
B meiosis occurs in both males and females.
C characteristics carried on the sex chromosomes are inherited only by females.
D the males are produced asexually.

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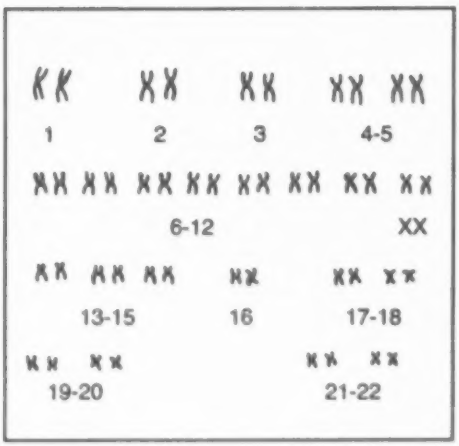
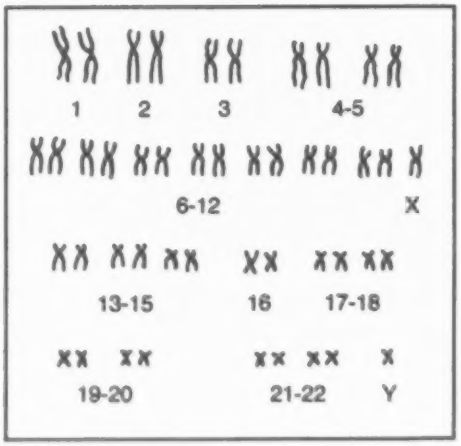
INCORRECT response items

14e-3 – Ap 2 (I) C Consider the two figures of arranged and numbered chromosomes. These chromosomes came from individuals who are twins:





From this data it would be reasonable to assume that

- **A** the twins are of different sexes.
- **B** the twins are chromosomally normal.
- **C** the twins may have arisen from a normal zygote which split into two parts early in development.
- **D** each twin has the same number of autosomes and sex chromosomes.

14e-4 14b Ap 2 (I) C A fine hair was tied around a dividing tadpole embryo at the two-cell stage resulting in separation of the cells. Each of the cells developed into a complete tadpole.

You could reasonably predict that the two tadpoles must

- **A** have the same number of chromosomes.
- **B** have the same genotype.
- **C** have the same phenotype.
- **D** be of the same sex.

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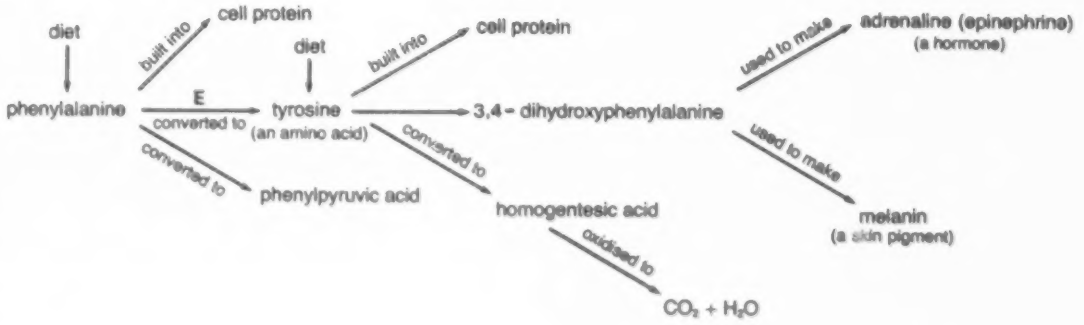
Patterns of Inheritance

14f—Alleles and their origin; types of dominance

CORRECT response items

14f-1
13e
An
5
(c)
D

The diagram below illustrates some of the biochemical pathways associated with the metabolism of phenylalanine.



Phenylketonuria (PKU) is a metabolic disorder which if undetected in the homozygous individual leads to mental retardation. Individuals with this disorder lack an enzyme indicated as 'E' in the diagram. Without the enzyme, phenylpyruvic acid accumulates in the cerebrospinal fluid. Individuals with the condition are detected soon after birth by a screening test which is performed routinely by hospitals on all newborn babies. Heterozygotes for the condition can be detected with reasonable certainty by a test for high levels of phenylalanine in their blood. They do not develop mental retardation.

Which of the following is the **least** correct about PKU?

A PKU sufferers will also show evidence of albinism.
B A low tyrosine diet impairs tissue growth in PKU sufferers.
C PKU can be controlled by a diet low in phenylalanine.
D The mutant gene for PKU shows incomplete dominance.

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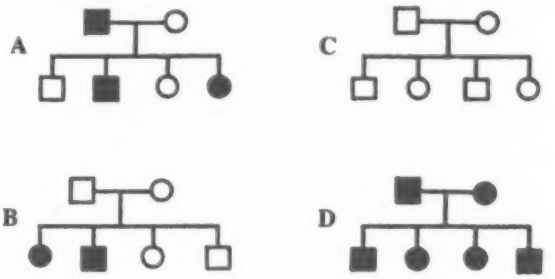
14f-2 – Co 2 (c) B

In the following human pedigrees, non-tasters for the substance PTC (phenyl thiocarbamide) are indicated by shading.

Which pedigree illustrates conclusively that non-tasting for PTC is a recessive character?



14f-3 – An 4 (c) A

Rh negative children (those not producing rhesus antigen D) may be born to either Rh positive or Rh negative parents but Rh positive children always have at least one Rh positive parent.

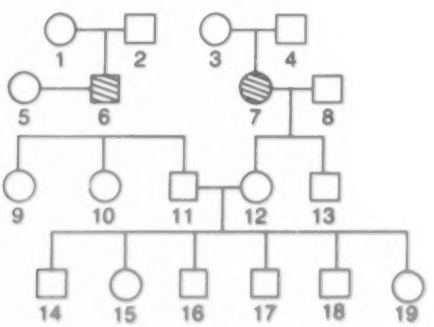
If the phenotype of an offspring is Rh negative, then its genotype is

A homozygous recessive.
B homozygous dominant.
C heterozygous.
D Rh^-.

INCORRECT response items

14f-4 – 4 (i) B

Humans vary in their ability to taste certain chemical compounds. In the following pedigree, shaded individuals lack the ability to taste phenylthiourea. Such people are called 'non-tasters', whereas people who can taste this chemical are called 'tasters'.



Examination of the pedigree enables a biologist to say that

A the genotypes of individuals 11 and 12 may be such that they are able to have a 'non-taster' child.
B none of the children of individual 9 and a 'non-taster' could be 'tasters'.
C both parents of individual 2 may be 'tasters'.
D one of the parents of individual 8 may be a 'non-taster'.

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14f-5 15f Kn 2 (i) B

Factors in the environment which have been shown to increase the rate of mutation in an organism include the following.

A an increase in temperature
B extremely large populations of other similar organisms
C certain compounds such as some industrial and horticultural chemicals
D high energy radiations such as ultra-violet light, X-rays, and beta and gamma rays

14f-6 17n Co 3 (i) B

Mendel's discovery of the gene was not appreciated until 35 years later.

The reasons for this could include

A the lack of association of his results with other observable and supportive phenomena of that time.
B his failure to be able to predict future phenotypes, using his methods.
C his use of statistical methods which were foreign to his contemporary biologists.
D the neglect of contemporary scientists to duplicate his experiments.

14g—Gamete and genotype frequencies; monohybrid crosses, multiple alleles

CORRECT response items

14g-1 – Ap 1 (c) A

The coat colour of cats is a trait that is linked to the sex chromosomes. The gene for coat colour is carried on the X chromosome. Suppose that 'o' represents orange, 'b' represents black and that tortoise-shell cats show both colours in their coats.

An orange female (X^oX^o) is mated with a black male cat (X^bY).

Which of the following litters could be produced by this mating?

A tortoise-shell females and orange males
B orange females only
C orange females and tortoise-shell males
D orange females and orange males

14g-2 – Ap 2 (c) C

Rabbits may have long or short ears. A long-eared, homozygous dominant rabbit is mated with another long-eared, but heterozygous rabbit.

If 'L' represents the dominant allele and 'l' represents the recessive allele, which of the alternatives below best illustrates the genotype of the offspring?

A all long-eared
B LL and ll
C LL and Ll
D long-eared and short-eared

14g-3 – Ap 2 (c) B

In humans, albinism, the total lack of pigment, is due to a recessive gene. An albino man is to marry a normal woman, whose father is an albino, and they want to know the probability of their having albino children.

A genetic counsellor would advise them that the probability of their having albino children would be

A 0.
B $\frac{1}{2}$.
C 1.
D $\frac{1}{4}$.

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INCORRECT response items

14g-4 – Co 2 (I) C *

In the vinegar fly *Drosophila Melanogaster*, red eye colour is dominant to pink. Flies heterozygous for red eye colour were interbred and a total of 1680 offspring was produced.

One would expect that

A the number of pink-eyed flies would be approximately 420.
B the red and pink characters are alleles of the same gene.
C any red-eyed offspring would all have the same genotype.
D alleles for eye shape would not occupy the same locus as the red and pink characters.

14g-5 14e Ap 3 (I) A *

Chromosome number in the grasshopper *Austroicetes pusilla* varies with sex. Females have 24 chromosomes while males have 23 chromosomes, and both females and males have 22 autosomes.

In this species

A sex-linked characteristics would be inherited only by females.
B both males and females would be produced sexually.
C all sperm produced by the males should be capable of fertilizing an egg.
D both eggs and sperm would be produced by meiosis.

14g-6 – Ap 3 (I) B

A light-coloured type of fox fur, termed platinum, was first detected at a Norwegian silver fox farm about 60 years ago. Platinum (P) was found to be dominant to silver-coloured fur (p). As platinum fur brought high prices at auctions, breeders were anxious to obtain a pure-breeding strain of this valuable variety. To this purpose they mated foxes heterozygous for the platinum character. These crosses yielded some platinum in addition to silver cubs, and it was expected that some of the platinum cubs would be homozygous for the platinum character, and hence would provide the basis for a pure-breeding strain. However none of the platinum cubs was pure-breeding. It was concluded that the gene for the platinum character is lethal in the homozygous state (i.e. a zygote homozygous for platinum does not develop).

All of the following observations would support this conclusion.

A Litter sizes from matings of platinum foxes are smaller than those from matings of silver foxes.
B Inbreeding in silver foxes yields only silver cubs.
C Test crosses of platinum foxes always yield platinum and silver cubs in the ratio 1:1.
D From matings of platinum foxes the ratio of platinum to silver cubs is 2:1.

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14h—Independent assortment of two or more genes on different chromosomes

CORRECT response items

The next 4 items refer to the following information:

In watermelons green fruit colour is dominant to striped, and short fruit is dominant to long. The genes controlling the two characteristics are inherited independently. Crosses were made between plants heterozygous for these characteristics.

14h-1 What proportion of plants from the crosses would be expected to have long green fruit?

– Ap 2 (c) B

A $\frac{9}{16}$ C $\frac{1}{16}$

B $\frac{3}{16}$ D $\frac{1}{4}$

14h-2 Of the F_1 plants with long green fruit, what proportion would be expected to be pure-breeding?

– Ap 2 (c) C

A all C $\frac{1}{3}$

B $\frac{1}{2}$ D none

14h-3 What proportion of plants from the crosses would be expected to have long striped fruit?

– Ap 3 (c) C

A $\frac{9}{16}$ C $\frac{1}{16}$

B $\frac{3}{16}$ D $\frac{1}{4}$

14h-4 Of the F_1 plants with long striped fruit, what proportion would be expected to be pure-breeding?

– Ap 3 (c) A

A all C $\frac{1}{3}$

B $\frac{1}{2}$ D none

INCORRECT response items

14h-5 In guinea pigs, rough coat R is dominant to smooth coat r and black coat B is dominant to white coat b. Two guinea pigs which were heterozygous for these characteristics were mated and produced young with four different phenotypes.

– Ap 1 (l) D

Each of the following phenotypes would result from genotypes containing either or both B and R.

A rough black C smooth black

B rough white D smooth white

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14h-6 – Co 2 (l) A

In chickens, white-speckled feather colour (W) is dominant to black (w), curly feather shape (C) is dominant to straight (c), and the presence of feathers on the legs (F) is dominant to bald legs (f).

Each of the following could be the genotype of a hen with straight white-speckled feathers on its legs.

A ccwwFf
B ccWwFf
C ccWwFF
D ccWWFf

14i—Linkage, crossing-over, chromosome mapping

CORRECT response items

14i-1 – Ap 3 (c) D

In maize the character plump seed (Sh) is dominant to shrunken seed (sh), and coloured seed (P) is dominant to colourless (p). Two homozygous plants were crossed, producing an F_1 all phenotypically plump and coloured. The F_1 plants were test crossed and the results obtained are tabulated below. (In a **test cross** the individuals are crossed with recessive individuals. In this case the F_1 plants are therefore crossed with shrunken colourless individuals, i.e. double recessive individuals.)

Phenotype of seed	*Number*
shrunken, colourless	1915
shrunken, coloured	81
plump, colourless	79
plump, coloured	1925
Total	4000

From this information a biologist is able to say that

A the genotype of the F_1 individuals was $\frac{\text{Sh p}}{\text{sh P}}$.

B the genes controlling seed shape and colour are assorting independently.

C the genotypes of the homozygous parents were $\frac{\text{Sh p}}{\text{Sh p}}$ and $\frac{\text{sh p}}{\text{sh p}}$.

D if the shrunken colourless seeds from the test cross were themselves test crossed, all the offspring would be shrunken and colourless.

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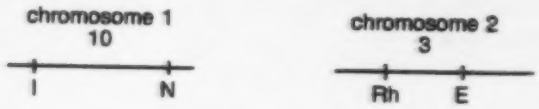
The next 3 items refer to the following information:

The diagrams below show the relative position of some genes on two chromosomes which do not form a pair (call them chromosome 1 and chromosome 2).



I denotes the gene controlling ABO blood groups; this gene exists in three alternative forms—I^a, I^b, I^o.

N denotes a gene controlling nail formation; this gene has two alternative forms—N and n.

Rh denotes the gene controlling Rh blood groups; the two alternative forms of this gene are Rh and rh.

E denotes a gene controlling shape of red blood cells; this gene has two alternative forms—E and e.

Consider an individual with genotype $\frac{I^o\ N}{I^b\ n}\ \frac{Rh\ e}{rh\ E}$

This way of writing the genotype shows that the alleles I^o and N occur on chromosome 1 and the alleles I^b and n occur on the chromosome which pairs with chromosome 1. Similarly the alleles Rh and e occur on chromosome 2 and the alleles rh and E occur on its pairing chromosome. One gamete which could be formed by this individual is I^o N. This shows that, in the gamete, chromosome 1 has the alleles I^o and N.

14i-2 – Co 2 (c) D Which one of the following gametes, derived from a person with the genotype $\frac{I^o\ N}{I^b\ n}\ \frac{rh\ E}{Rh\ e}$ would be termed recombinant?

A I^b n Rh e
B I^b n rh E
C I^o N Rh e
D I^o n Rh E

14i-3 – Ap 3 (c) C In a person of genotype $\frac{I^a\ N}{I^b\ n}\ \frac{Rh\ E}{rh\ e}$ which one of the following gametes would be expected to occur **least** frequently?

A I^b N rh e
B I^a N rh e
C I^a n rh E
D I^a N Rh E

14i-4 – Ap 3 (c) C Consider a person with the genotype $\frac{I^a\ n}{I^o\ N}\ \frac{rh\ e}{Rh\ E}$.

This person would produce

A more gametes containing I^a n than I^o N.
B more gametes containing rh e than Rh E.
C the same number of gametes containing rh E as Rh e.
D approximately the same number of gametes containing I^a N as rh E.

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The next 2 items refer to the following information:

In the vinegar fly *Drosophila melanogaster*, the following data are available:

gene 1: normal grey body colour (E) is dominant to ebony body colour (e)

gene 2: normal red eye colour (S) is dominant to sepia eye colour (s)

Drosophila with ebony body colour and sepia eyes were crossed with flies heterozygous for both body colour and eye colour. A great many offspring were produced.

14i-5 – Co 2 (i) A One would expect that

A with no crossing over, this cross would yield only one phenotype if the gene loci are linked.

B if crossing over occurs, this cross would yield four phenotypes if the gene loci are linked.

C if the gene loci are not linked, four phenotypes should result.

D if the gene loci are not linked, four genotypes should result.

The next item refers to the following ADDITIONAL information:

The results showed that the two gene loci are linked.

Further crosses were made, and the following information obtained:

Fly W: homozygous for normal body colour and sepia eyes.
Fly X: homozygous for ebony body colour and normal red eyes.
Fly Y: produced from a cross between flies W and X.
Fly Z: had ebony body colour and sepia eyes.

14i-6 – Ap 4 (I) B One could reasonably conclude that

A fly Z would produce gametes of only one kind.

B fly Y has genotype $\frac{ES}{es}$

C if flies Y and Z are crossed, any offspring with grey body and red eyes would be the result of crossing over.

D fly W would produce gametes of only one kind.

14i-7 17e Ap 4 (I) C In maize there are two alleles for kernel colour and shape. The kernel, which represents the seed of the plant, is either coloured or colourless and either smooth or shrunken. Colour is dominant to colourless and smooth is dominant to shrunken.

In a breeding experiment to determine whether the gene for colour exists on the same chromosome as the gene for shape, a maize plant pure breeding for coloured and smooth kernels was crossed with one pure breeding for colourless and shrunken kernels. The F_1 was then crossed to obtain the F_2 generation.

Assuming that no crossing over occurs, the following statements support the hypothesis that the genes for colour and shape are situated on the one chromosome.

A Fifty per cent of the F_1 gametes receive genes for coloured and smooth kernels.

B The number of genotypes possible in the F_2 is three.

C The probability of the P gametes receiving genes for colourless and shrunken kernels is one.

D The number of phenotypes possible in the F_2 is two.

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14I-8 – Ap 4 (I) B

A geneticist investigated the relationship between flower colour and pollen grain shape in the sweet-pea. It is known that the allele for purple flowers (P) is dominant to the allele for red flowers (p), and that the allele for long pollen grains (L) is dominant to that for round pollen grains (l). An experiment was carried out as follows:

P:	pure breeding purple flowers, long grains			X	pure breeding red flowers, round grains		
F_1:	all purple flowers, long grains						
Test cross:	F_1 purple flowers, long grains			X	red flowers, round grains		
Offspring:	purple flowers, long grains		purple flowers, round grains		red flowers, long grains		red flowers round grains
Percentage:	46	:	5	:	7	:	42

It is reasonable to suggest from the experiment that

A the genotype of some of the gametes in the F_1 is $\frac{Pl}{PL}$

B crossing over between P and L occurred in 46 per cent of meiotic divisions in the F_1.

C crossing purple flowered, long grained peas in an F_2 generation with pure breeding double recessive parents would produce two phenotypes.

D the gene loci for flower colour and pollen grain shape are 12 map units apart on the same chromosome.

DNA, Genes and Chromosomes

14j—Chromosomes and genes consist of DNA; DNA may be extranuclear

CORRECT response items

14j-1 17d Co 4 (c) B

The model of the DNA molecule put forward by Watson, Crick, and Wilkins can be used as an aid to explain many observed characteristics of genetic material.

However, it fails to help explain

A why characteristics can be passed on from generation to generation without change.

B why different proteins are active at different times in the cell.

C how DNA molecules replicate themselves.

D how DNA determines the order of nucleotides in RNA.

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INCORRECT response items

14j-2 – Ap 2 (I) D

In certain cells of some insects the homologous chromosomes come together, pair closely and never separate. At specific times in the life of the cell the chromosome material duplicates but remains together.

Each band is regarded as the site of a specific gene.

It would be reasonable to conclude that

A the band regions of 'giant chromosomes' contain DNA.
B the cells of an insect with a diploid number of 12 would contain 6 'giant chromosomes'.
C each 'giant chromosome' contains a large number of genes.
D cells containing 'giant chromosomes' undergo normal mitotic and meiotic division.

Gene Action

14k—How gene structure determines protein synthesis

CORRECT response items

14k-1 – Kn 1 (c) A

In protein synthesis the sequential action of the nucleic acids DNA and RNA can be expressed as

A DNA, messenger-RNA, transfer-RNA.
B transfer-RNA, messenger-RNA, DNA.
C DNA, transfer-RNA, messenger-RNA.
D messenger-RNA, DNA, transfer-RNA.

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14k-2 – Ap 3 (c) C

Evidence for the way DNA replicates comes from an experiment using a heavier isotope of carbon (^{14}C) than the common one (^{12}C). Bacteria were supplied with a carbon food-source that contained the heavy isotope and so made nucleotides containing this isotope. (Because there are so many carbon atoms in a nucleotide, substitution of ^{14}C for ^{12}C changes the molecular weight by an appreciable amount; after many generations this bacterial DNA has a higher molecular weight than that of bacteria grown on a ^{12}C food-source.)

The procedure for the experiment is as follows:

Experiment 1: Bacteria grown on ^{14}C food-source, then DNA isolated.
Experiment 2: Bacteria grown on ^{12}C food-source, then DNA isolated.
Experiment 3: Bacteria grown for many generations on ^{14}C food-source, then put on to ^{12}C food-source and DNA isolated after one cell division.

Let MW1 represent the molecular weight of the DNA isolated in Experiment 1, MW2 be that for Experiment 2, and MW3 that for Experiment 3.

Comparison of the three molecular weights would show that MW3 has a value

A similar to MW1.
B similar to MW2.
C halfway between MW1 and MW2.
D anywhere between MW1 and MW2.

14k-3 – Ap 4 (c) B

There are three mutant strains of the fungus *Neurospora*, each with a mutation of one particular gene. As a result of its mutations a particular strain can be grown only when certain chemicals are added to the minimal medium on which the normal strain will grow. Hence:

No. 1 (normal) grows on minimal fungus medium.
No. 2 grows only on minimal medium supplemented with amino acid A.
No. 3 grows only on minimal medium supplemented with either amino acid A or amino acid P.
No. 4 grows only on minimal medium supplemented with any one of amino acids, A, P, and S.

This suggests that, in the normal *Neurospora*, the sequence of amino acids in the biochemical pathway is

A A⟶P⟶S.
B S⟶P⟶A.
C P⟶S⟶A.
D S⟶A⟶P.

INCORRECT response items

14k-4 – Co 2 (l) C

A particular live cell synthesizes the following amino acid chain:

met — his — tyr — ser — gly — phe

The codons that specify for the individual amino acids are.

amino acid	gly	his	met	phe	ser	tyr
codon	GGG	CAC	AUG	UUU	UCU	UAC

It is reasonable to assume that

A the messenger-RNA sequence that specifies for the amino acid sequence is AUG — CAC — UAC — UCU — GGG — UUU
B the DNA base sequence that specifies for the amino acid sequence is TAC — GTG — ATG — AGA — CCC — AAA
C the complementary DNA strand has the sequence AAA — CCC — AGA — ATG — GTG — TAC
D the tRNAs involved have the base codes, in order of action UAC — GUG — AUG — AGA — CCC — AAA

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14k-5 – Kn 5 (I) B The following events occur when the DNA molecule replicates.

A The bonds between complementary base pairs break and the DNA strands separate.
B Free bases within the nucleus pair with complementary bases on a single DNA strand.
C A single DNA strand acts as a template for the synthesis of additional DNA molecules.
D Bonds form between successive nucleotides due to the action of enzymes and the expenditure of ATP.

The next 3 items refer to the following information:

In 1963, V.M. Ingram found that sufferers of the hereditary blood disorder *sickle cell anemia* possessed a haemoglobin (type S) that differs from normal haemoglobin (type A) in only one minute respect. Only a single amino acid in one of the peptide chains was different. The peptides involving the difference are:

haemoglobin A (normal)	thr — pro — glu — glu — lys
haemoglobin S (sickle-cell)	thr — pro — val — glu — lys

The correspondence between the peptide amino acids and mRNA codons are given in the following table:

Amino acid	Codons in mRNA molecule
threonine (thr)	ACU or ACC or ACA or ACG
proline (pro)	CCU or CCC or CCA or CCG
glutamic acid (glu)	GAA or GAG
lysine (lys)	AAA or AAG
valine (val)	GUU or GUC or GUA or GUG

14k-6 – Co 2 (I) D The part of the DNA molecule that controls production of the above haemoglobin A peptide could have the base sequence

A TGA — GGG — CTC — CTT — TTT
B TGT — GGG — CTT — CTT — TTC
C TGC — GGC — CTT — CTC — TTC
D TGG — GCG — CTC — CTT — TTT

14k-7 – Co 4 (I) C The sickle-cell mutation could have arisen by any of the following changes in the DNA segment.

A the middle T of the segment being substituted by A
B the eighth and ninth bases of the segment being substituted by AG
C the ninth base of the segment being substituted by G
D the eighth and ninth bases of the segment being substituted by AA

14k-8 – Co 4 (I) C Considering the mRNA coding for the peptide from hemoglobin A,

A if the fourth base in this mRNA molecule was substituted by A, then the peptide thr — thr — glu — glu — lys would be produced.
B the base sequence of this mRNA molecule is different from that coding for the peptide thr — pro — glu — lys — glu.
C if the sixth base in this mRNA molecule was deleted, this would alter the second amino acid.
D a tRNA molecule containing the sequence UUU or UUC would match up with bases 13 to 15 in this mRNA molecule.

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14k-9 DNA controls the activity of the cell by
–
Co
3
(I)
B

A producing messenger-RNA which moves into the cytoplasm.
B matching amino acids with the codons on messenger-RNA.
C transcribing information into transfer-RNA.
D directing the synthesis of ribosomal-RNA.

14k-10 It would be possible to manufacture large quantities of a polypeptide using the cellular machinery of bacteria, provided
–
Ap
2
(I)
D

A the appropriate DNA nucleotide sequence could be inserted into the DNA strand of the bacterium.
B the bacterium treats the introduced DNA segment as its own and replicates it as it divides.
C the bacterium transcribes the introduced DNA segment to messenger-RNA.
D the ribosomal-RNA and transfer-RNA necessary for translation are introduced into the bacterium.

14l—Phenotype as gene expression

CORRECT response items

14l-1 Considering the current evidence for the control of gene action, which of the following
14m statements is correct?
Co
3
(c)
B
•

A As a multicellular organism develops from a single cell, the new cell types develop new genes to direct the new functions these cells will have in the adult.
B Cells from different tissues of a multicellular organism differ primarily because different genes are used to make the particular proteins required by the two cells.
C If a cell in a multicellular organism is to function properly, all its genes must be available to operate when required.
D A single-celled organism has all the genes it requires to develop into a multicellular organism, but it is prevented from doing so because many of its genes are 'switched off'.

INCORRECT response items

14l-2 The functioning of many hormones depends on their ability to affect the activity of certain genes. It
–
An
2
(I)
C

has been shown that 30 minutes after administration of oestrogen there is a marked increase in the synthesis of RNA by uterine cells, and a rise in protein synthesis two to four hours later. The activity of genes can be blocked by the action of the antibiotic, actinomycin, which penetrates the cell and forms a complex with DNA. Depending on the amount given, the antibiotic decreases or totally prevents the formation of messenger-RNA.

You could reasonably expect the following to occur in mouse uterine cells after administering actinomycin.

A no rise in protein production
B decreased movement of amino acids across cell membranes
C increased production of ADP from ATP
D decreased production of transfer-RNA

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14I-3 – Co 3 (I) B

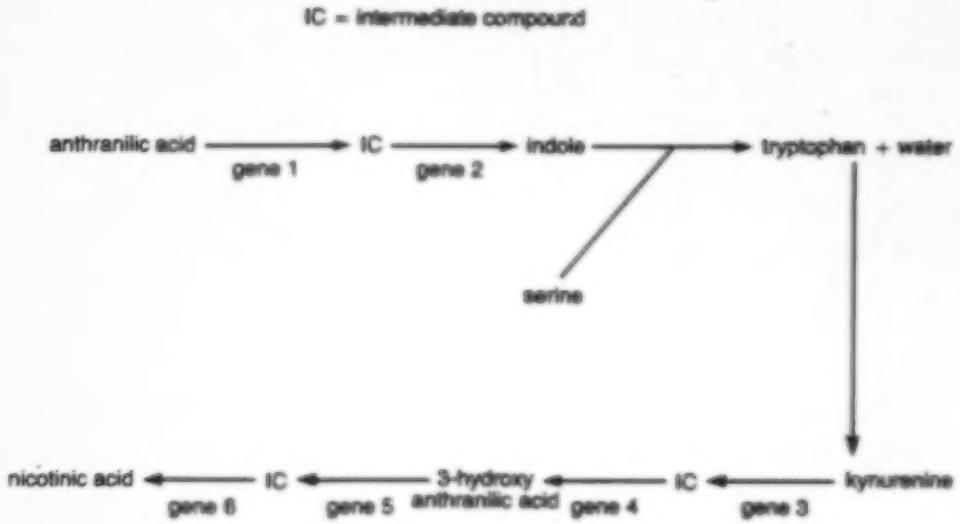
Nucleosomes at one end of a DNA chain can be induced to 'unpack' themselves by the action of very dilute potassium cyanide.

In cells thus treated you would expect an increase in

A protein synthesis in the cytoplasm.
B the binding of histones to phosphate.
C the uptake of oxygen by the cell.
D the rate of diffusion of amino acids into the cell.

14I-4 – Co 4 (I) D

Nicotinic acid (niacin) and tryptophan are necessary to animal and plant cells. Nicotinic acid is one of the B vitamins required by mammals, and deficiency of this vitamin in the diet causes a disease called *pellagra* in man and *black-tongue* in dogs. The manufacture of nicotinic acid from the precursor (starting compound), anthranilic acid, is shown below.



It would be reasonable to predict that

A if gene 1 were defective, there would be an accumulation of anthranilic acid in the cell.
B if genes 1 and 2 were functioning normally and serine was provided in the medium, nicotinic acid need not be provided.
C humans receiving diets rich in typtophan would not develop pellagra.
D a diet containing tryptophan and nicotinic acid would be necessary to cure black-tongue.

14m—Gene activity controls cellular activities

CORRECT response items

14m-1 – Kn 4 (c) C

Nucleosomes are

A sites of messenger-RNA synthesis.
B composed of histones and RNA.
C associated with specific sections of DNA.
D found where there is chromosome puffing.

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INCORRECT response items

14m-2 – Kn 3 (I) B

Each of the following is true of histones.

They

A are proteins of relatively small size.
B are produced in the ductless glands and then transported.
C are parts of nucleosomes in chromatin fibres.
D have positive charge in neutral solutions.

14m-3 14I Kn 3 (I) C

A phenomenon known as 'puffing' is found in the giant chromosomes of certain tissues in *Drosophila* larva.

The present evidence suggests that

A puffed bands contain characteristic non-histone proteins.
B RNA is synthesized at sites where puffing occurs.
C puffing occurs where dark-staining bands are observed.
D puffing can occur in different sequences at different times.

14m-4 14I Kn 4 (I) A

Nucleosomes are

A sites of messenger-RNA synthesis.
B composed of histones and DNA.
C not sites of protein synthesis.
D associated with specific sections of DNA.

14m-5 – Co 3 (I) B

When considering the nuclear genetic material within an active mature mouse kidney cell

A there is the same number of chromosomes as in a mouse brain cell.
B all the genes on each chromosome are active in controlling the cell's functions.
C some non-histone proteins accumulate before messenger-RNA is produced and released.
D there are the same types of genes as in a heart muscle cell but with some different nucleosomes.

14m-6 – Ap 4 (I) C

All cells of a multicellular organism develop from a single cell, the zygote. Cell differentiation occurs between the zygote and adult stages.

Each of the following could help explain how differentiation occurs.

A Histones prevent transcription of DNA into RNA.
B Enzymes responsible for transcribing DNA into RNA may be inactive.
C Products of gene translation do not inhibit the transcription of DNA.
D Histones may bind to DNA forming nucleosomes.

14m-7 – An 3 (I) A

Chromosome puffs have been observed on giant chromosomes in larval tissues of the fruit fly, *Drosophila*. The following could be used as evidence that chromosome puffs are sites of RNA synthesis.

A Injection of an antibiotic known to inhibit RNA synthesis does not prevent puff formation.
B Formation of puffs can be induced by injecting growth hormone into the insect.
C A hormone which induces a puff at a certain location on a chromosome of a salivary gland cell does not induce a puff at the same location on chromosomes of other types of cells.
D Radioactive tracers can be taken up in chromosome puffs, and radioactive RNA is released.

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15 Life—its Continuity and Change

Life from the Past

15a—Fossils and their formation; geological time scale

CORRECT response items

15a-1 Most fossil remains are of aquatic rather than terrestrial organisms.
– Co 2 (c) D
Which one of the following is the best explanation for this?

A Aquatic organisms have more hard parts in their bodies than terrestrial organisms.
B Sedimentary rocks are not formed in a terrestrial environment.
C Dead terrestrial organisms are more likely to decompose than dead aquatic organisms.
D Dead aquatic organisms are more likely to become covered with sediments.

15a-2 Which one of the following would be the most valuable fossil species for confirming that two rocks from different areas were of the same age?
– Co 2 (c) C

A a species of mollusc unique to the particular areas
B a species of terrestrial organism with known specific climatic requirements
C a species which left fossils over much of the earth's surface although it existed for only a short period of geological time
D a species of marine organism which is known to have lived only where specific environmental conditions existed

15a-3 The ratio of carbon-14 to carbon-12 in living organisms is 1 in 10^{12}. The half-life of carbon-14 is about 5500 years. The proportion of carbon-14 to carbon-12 in a sample of charcoal found buried beside an aboriginal axehead was $\frac{1}{8}$ in 10^{12}.
– Co 3 (c) C
It would be reasonable to assume that the age of the axehead was about

A 0.125×10^{12} years ($\frac{1}{8} \times 10^{12}$).
B 687 years ($5500 \div 8$).
C 16 500 years (5500×3).
D 22 000 years (5500×4).

15a-4 The fossil record of animal evolution is incomplete.
– Co 3 (c) A
Which of the following explanations is **least** useful in helping to explain this observation?

A Because some fossils have no living organisms closely related to them, they are difficult to classify.
B Some strata have not yet been exposed to reveal their fossil content.
C Previous breaking, heating and bending of rocks have altered some fossils beyond recognition.
D Erosion has already removed many sedimentary rocks and their fossil content has been destroyed.

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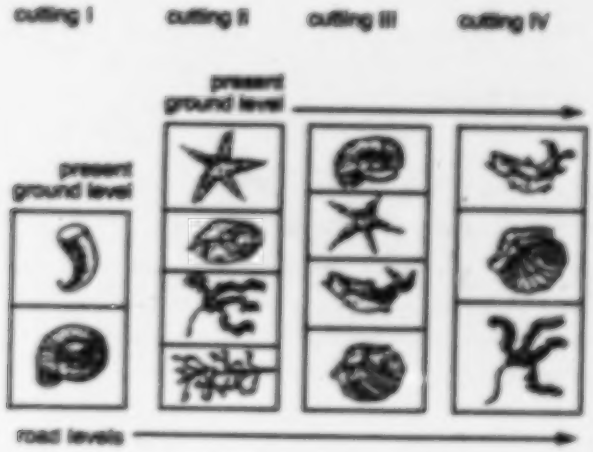
The next 4 items refer to the following information:

The diagrams represent the rock strata and fossils exposed at the side of a road in four different cuttings. Assume that the fossils under consideration occur in the order in which they were deposited.



15a-5 The oldest stratum is exposed in cutting

Co 3 (c) B

A I.
B II.
C III.
D IV.

15a-6 The oldest fossil which can be found at present ground level occurs in cutting

Co 3 (c) D

A I.
B II.
C III.
D IV.

15a-7 At the time when the strata were laid down, which species had the highest population density?

Co 3 (c) D

A

B

C

D There is insufficient information to decide.

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The following diagram represents one fossil species type.

15a-8 – Co 4 (c) A Which one of the following best explains why this species does not appear in the rock sample from cutting I?

- **A** The road was not cut deeply enough to give information on this stratum.
- **B** The species was free-swimming and had moved away from this area at the time when this stratum was being laid down.
- **C** The stratum containing the species was not deposited because currents did not carry sediments to the area now exposed in this cutting.
- **D** Relatively recent erosion had removed the stratum containing this species.

15a-9 – Kn 2 (c) D • Palaeontologists find fossilized remains of some groups of organisms more commonly than other groups.

Which factor is **least** likely to determine the chances of part or all of an organism being fossilized?

- **A** its habitat
- **B** geological events following its death
- **C** its structure and chemical composition
- **D** its population size

The next 2 items refer to the following information:

Near Leongatha in Victoria, a very rich fossil site of the Cretaceous period has been discovered. The fossils found there include insects, their larvae, many large and small fishes, small snails and crustaceans, ferns, leaves, twigs, pollen, spiders, and a feather of a seabird. The fossils are found in a fine-grained yellow mudstone. The fossils are in an almost perfect state of preservation, particularly the fish in which even the finest details of bones, scales, and even the structure of the internal organs have been preserved. Between the fossiliferous layers are thin layers of silt without any fossils.

15a-10 – Co 4 (c) D Which of the following interpretations of the locality of the original ecosystem is most consistent with the evidence in the passage?

- **A** The mudstone was a marine deposition.
- **B** The mudstone was deposited in turbulent freshwater streams.
- **C** Deposition was in a swamp region between sand dunes.
- **D** The area was a coastal one.

15a-11 – Co 3 (c) A All of the following are consistent with the evidence in the passage **except** one. Which one?

At the time of deposition

- **A** there were stagnant pools where decomposer organisms attacked dead material.
- **B** there were flowering plants growing in the locality.
- **C** the fish may have died from lack of oxygen associated with a sudden inrush of silty water.
- **D** it is probable that an ecosystem resembling that of a modern forest existed.

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15a-12 – Co 4 (c) B *

The Precambrian era is the earliest era in the geological time scale and represents more than 80 per cent of geological time. However very few fossils are found in the Precambrian era rocks.

All of the following are reasonable explanations for this fact **except** one. Which one?

A Precambrian rocks have undergone considerable changes and disruptions.
B Precambrian rocks are rarely exposed at the surface of the earth.
C Most of the organisms living in the Precambrian era were soft-bodied.
D The number of organisms in the Precambrian era was limited.

15a-13 17b Ap 1 (c) C

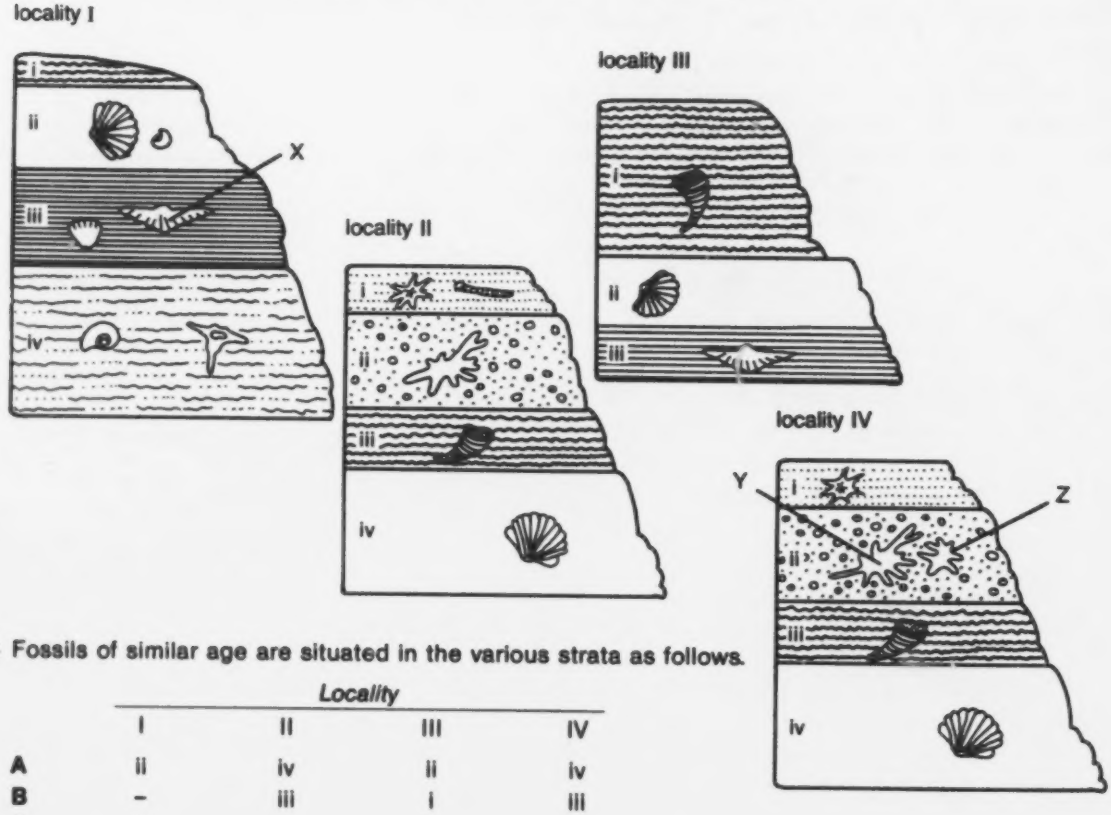
Diprotodon is a marsupial that has been reconstructed by scientists from fossils found at Lake Callabonna in South Australia. Scientists believe this animal was a herbivore.

Evidence **most** likely to support this hypothesis would be that

A remains of plant material are found near the digestive region of *Diprotodon*.
B fossil remains of tropical vegetation are associated with *Diprotodon* bones.
C *Diprotodon* teeth have a similar structure to those of modern day herbivores such as wombats.
D the length of the neck of a *Diprotodon* suggests a browsing method of feeding.

INCORRECT response items

The next 3 items refer to the following information:
The rock strata at each of four localities are indicated in the diagrams.



15a-14 – Co 2 (I) D

Fossils of similar age are situated in the various strata as follows.

	Locality			
	I	II	III	IV
A	ii	iv	ii	iv
B	–	iii	i	iii
C	iii	–	iii	–
D	–	i	–	ii

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15a-15 Comparing localities I and III it can probably be said that

–
Co
2
(i)
B

A only some of the organisms found at locality I also existed at locality III.
B older fossils occur at locality III than at locality I.
C fossils in stratum iv at locality I would be found beneath stratum iii at locality III.
D both sites once experienced similar climatic conditions.

15a-16 You could reasonably conclude from the data that

15b
Co
2
(I)
D

A organism X eventually became extinct at localities I and III.
B the four localities were once marine habitats.
C different fossils may occur in the same rock-type at different localities.
D organism Y evolved from organism Z.

15a-17 The parts of an organism most likely to become fossilized are

–
Kn
1
(I)
B

A teeth.
B internal organs.
C scales.
D feathers and hair.

15a-18 Prehistoric habitats most likely conducive to fossil formation would be

–
Kn
2
(I)
A

A deserts.
B swamps.
C rivers.
D oceans.

15a-19 The following features were found within a slab of rock.

–
Co
2
(I)
C

Each of them can be classified as a fossil.

A the footprints of a dinosaur
B the egg of a pterodactyl
C impressions of rain splashes
D the burrows of a worm

15b—Evidence of change in the fossil record

CORRECT response items

15b-1 From an examination of fossils found at a particular place, scientists can describe past climates in that place.
15a
Co
2
(c)
B

The most important assumption they make is that

A the fossils are identical with those found in similar rocks at different localities.
B fossils similar to present-day organisms had similar requirements.
C past climates were generally warmer than present-day ones.
D radiocarbon dating is sufficiently accurate for determining the age of fossils.

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The next 6 items refer to the following information:

Statements (i)—(iii) are about a technique called pollen analysis.

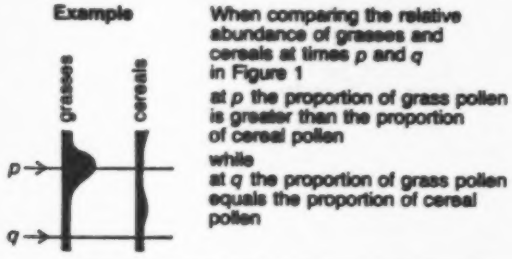
(i) Pollen grains are highly resistant to decomposition and remain in identifiable forms over very long periods of time.

(ii) A pollen spectrum (plural:spectra) for an archaeological site is developed by
—collecting all the pollen grains in a sample of earth and sorting them into species:
—counting the grains of each species represented in the sample, and thus estimating the proportion of trees of each species likely to have been growing in the area.

(iii) Pollen spectra taken at many sites in a country or continent may be used to establish general **pollen zones** for that country or continent. Such zones give a broad picture of successive eras of vegetation (and thus climatic and human habitation) for the territory as a whole.

Figure 1 is based on an analysis of pollen samples, and shows the development of vegetation in northern Europe from the late glacial period (bottom) to recent times (top).

The width of each plant column represents an estimate of the relative abundance of each plant type—the thicker the column, the greater the abundance.


Example
grasses
cereals
p
q
When comparing the relative abundance of grasses and cereals at times p and q in Figure 1
at p the proportion of grass pollen is greater than the proportion of cereal pollen
while
at q the proportion of grass pollen equals the proportion of cereal pollen

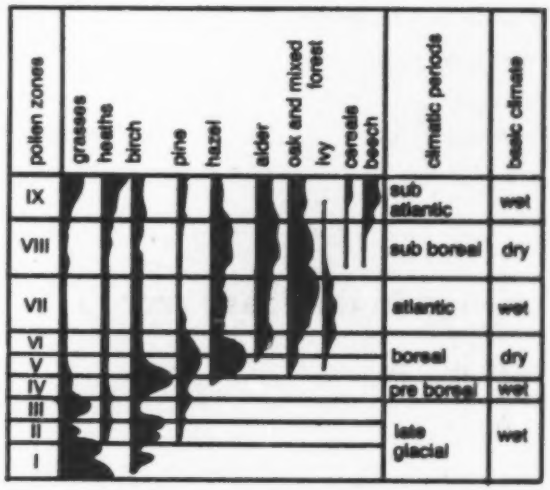


Figure 1

15b-2 17k Co 1 (c) D *

Which one of the following best describes the development of vegetation during late glacial times?

A There were large forests of pine and birch, which were replaced by grasslands as the climate became warmer.

B At first there were just grasslands; these were first replaced by pines, then by three distinct forests of birch.

C There were distinct forests of birch throughout the period; the rest of the vegetation was grass and heath in equal proportions.

D Vegetation consisted mainly of grasslands which became dotted with forests of birch and, in the later stages, with a few pines and heaths.

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15b-3 17k Ap 2 (c) C *

Which of following studies would be influenced most by an examination of the site's pollen spectra?

A the eating habits of humans occupying the site during a set period of time
B the positions of particular species of trees in a field at the site
C the climatic changes that took place in the area over a long period of time
D the types of implements and tools used by the humans settled at the site

15b-4 17k Ap 1 (c) B *

An archaeologist, studying a particular site, found evidence of a sudden decline in the pollen of forest trees and a simultaneous increase in the pollen of heaths and grasses. The archaeologist suggested that this pointed strongly to human activity.

Which one of the following would provide the most useful support for the above hypothesis?

A evidence that some of the pollen at the site had been destroyed by fire
B the discovery of hard flint tools at the site in the same layers of earth
C the discovery of similar abrupt changes in the pollen at neighbouring sites
D the absence of tree pollen in layers above the one investigated

The next 3 items refer to the following ADDITIONAL information:

In studying localized sites, archaeologists have been able to subdivide the major pollen zones. Figure 2 is based on an archaeological excavation in Cambridgeshire, England.

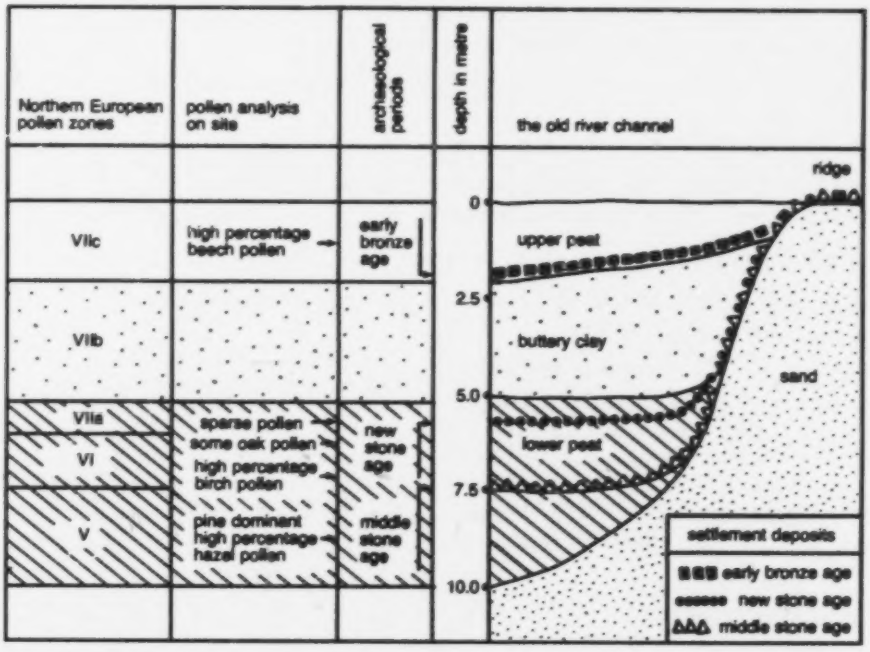

Figure 2: The Settlements at Peacock's Farm, Cambridgeshire, England

The sand ridge, illustrated at the right of Figure 2, flanks one side of an old river channel now filled with sediments as shown. Excavations of the river channel sediments down to a depth of 10 metres revealed three distinct levels. These are shown in cross-section on the right. Each level can be linked to one or more pollen zones and to one or more archaeological periods. These links are indicated in two of the columns at the left of Figure 2; the column between provides information on the results of pollen analysis at the site.

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15b-5 17k Co 2 (c) A *

In the North European pollen zones column in Figure 2, zone VII has been subdivided into three zones.

This is most probably attributable to

A the existence of three clear layers in that zone at the Peacock's Farm site.
B the richness and variety of pollen belonging to that zone.
C the considerable thickness of the buttery clay.
D a need to distinguish the pollen of the stone age from that of the bronze age.

15b-6 17k An 2 (c) C *

During the boreal and atlantic periods, vegetation in North Europe was basically the same as that in England.

Therefore the pollen samples collected with the new stone age settlement remains at Peacock's Farm were probably indicative of

A a predominance of grass, birch, and pine.
B a predominance of pine and heaths.
C forests of oak, alder, hazel, pine, and birch.
D heaths, hazel and pine, in roughly equal proportions.

15b-7 17k An 2 (c) C *

In terms of the pollen zones typical of North Europe as a whole, which one of the following findings at the settlements at Peacock's Farm would have been **least** expected?

A the presence of oak pollen in the lowest peat
B a high percentage of birch in parts of the lower peat
C a high percentage of cereal pollen in the upper peat
D a high incidence of pine and hazel in the lowest layers of the lower peat

---

15b-8 – Co 3 (c) C

After a study of the strata exposed on a cliff face, a geologist concluded that many thousands of years ago the environment in that place was generally warmer than it is at present.

Which of the following is **least** likely to have influenced his conclusion?

A the similarity of the fossils to organisms now found in tropical areas
B the presence of fossil reptiles
C the thickness of the strata containing the fossils
D a comparison of the fossils with present-day organisms in the same environment

15b-9 – Ap 2 (c) B

Both present-day magnolias and water lilies grow in habitats which are warm, temperate, and subtropical. The Jurassic rocks of Greenland and northern Scotland contain fossil pollen of magnolias and water lilies.

This can be best explained by the fact that, during the Jurassic period,

A parts of Greenland and Scotland were under water and pollen was carried by sea currents from warmer areas.
B the climates of Greenland and Scotland were warmer than they are now.
C pollen was carried from warmer areas by birds.
D the magnolias and water lilies in Greenland and Scotland evolved to form different species.

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INCORRECT response items

15b-10 – Ap 2 (i) A

Fossil materials have recently been found in the Simpson Desert in Central Australia. It has been suggested that this fossil material represents a direct ancestor of a present day herbivorous marsupial.

Evidence that supports this idea includes

A the presence of a pair of large canine teeth in the fossil jaw.
B fossil thigh bones that resemble those of the present day desert-dwelling marsupial mouse.
C indications from the fossil material that the animal had a pouch-like structure.
D the finding in younger rock deposits, of fossils which are intermediate in form between the Simpson Desert fossils and the present-day marsupial.

15b-11 – Ap 3 (i) B

Fossil remains of two organisms belonging to the same species (X) were found in a particular area. These fossils, denoted X_1 and X_2, each comprised a skull, a jawbone, several vertebrae, and a femur, and were shown to be the same age.

Tools found in association with fossils X_1 and X_2 were similar to tools found at a distant site in association with fossil Y, an organism of a different species.

Valid inferences that may be made include the following:

A Organisms of the type represented by fossils X_1 and X_2 may have lived in areas other than those in which these two fossils were found.
B The femur length and cranial capacity of fossil X_1 would be identical with those of fossil X_2.
C If species X evolved from species Y then these two species would possess some similar structural characteristics.
D Species X and Y did not necessarily evolve from a common ancestor.

15b-12 – Ap 4 (i) C

Changes in the fossil record indicate that

A new species are often formed from existing species.
B species have evolved in association with changes in past environments.
C most species have in the past undergone gradual changes in their physical characteristics.
D the earth has in the past undergone considerable changes in climate.

Natural Selection and Change

15c—Speciation, variation, selection and evolution

CORRECT response items

15c-1 17b Co 2 (c) D

From the following statements, select the one which gives **least** support to the modern theory of evolution.

A Fossil organisms similar to present-day organisms differ from the latter in certain features.
B All chordates have structural similarities.
C All mammals develop gill pouches during their embryonic development.
D There are many protozoans in the world today.

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15c-2 In *The Origin of Species* Charles Darwin wrote:

–
Co
2
(c)
D

> Although in oceanic islands the species are few in number, the proportion of endemic kinds (i.e. those found nowhere else in the world) is often extremely large. If we compare, for instance, the number of endemic land-shells in Madeira or of endemic birds in the Galapagos Archipelago, with the number found on any continent, we shall see that this is true.

This observation is best considered an example of

A speciation through mutation.
B variation within species.
C specific creation.
D evolution in isolation.

The next 5 items refer to the following hypothetical data:

A population of a species of annual plant (*Atkinsonia australis*) is growing on the floor of a valley and on the adjacent hillsides. Conditions in the valley tend to be more humid than on the hillsides and the soil is usually more moist. The hillsides are more exposed to winds. Careful study reveals that the *Atkinsonia* plants are not exactly alike. The three characteristics which show variation are

(i) plant height;
(ii) leaf size;
(iii) leaf texture (some plants have more leathery leaves with a thicker external waxy layer).

Although these characteristics vary throughout the population, an investigation in 1971 showed that the majority of hillside plants (Type H) are shorter with smaller tougher leaves, while on the valley floor there is a much higher proportion of taller plants with larger softer leaves (Type V).

The biologist conducting the investigation collected seeds from the characteristic types in each area (H and V) and planted them separately in an experimental plot where all plants experienced identical growing conditions. It was found that seedlings which grew from both types showed variation in the three characteristics mentioned. However, the majority of the plants which grew from seeds of Type H were shorter with smaller more leathery leaves, and the majority which grew from seeds of Type V were taller with larger softer leaves.

15c-3 17e Co 2 (c) A The results of the biologist's experiment provide evidence that differences in height, leaf size, and leaf texture among individuals of this species are

A inherited.
B determined by the microhabitats of the plants.
C affected by the growing conditions.
D the result of mutations in each generation.

15c-4 17e Co 2 (c) C Suppose the average rate of water loss from mature Type H plants and Type V plants was compared under identical conditions at a temperature of 25 °C and in a wind velocity of 30 kilometres per hour.

Which of the following results is most likely?

A Type V plants would probably grow faster than Type H plants.
B Type H plants would probably lose water more rapidly than Type V plants.
C Type V plants would probably lose water more rapidly than Type H plants.
D It is unlikely that there would be any appreciable difference in rate of water loss, since all the plants are of the same species.

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15c-5 17e Co 3 (c) C

Suppose the original study of the distribution of the varying types of *Atkinsonia australis* in the valley in 1971 was followed up by a further investigation in 1972 with closely similar results. Two students gave different explanations for the higher proportion of Type V plants than Type H plants on the *floor of the valley* in 1972:

Elaine: More Type V seeds were produced by the 1971 plants on the floor of the valley, hence there are more Type V plants in 1972.

John: Type V plants are able to compete more effectively for resources than Type H plants under the conditions which prevail on the floor of the valley.

The best explanation of the higher proportion of Type V plants on the valley floor in 1972 would include

A Elaine's statement only.
B John's statement only.
C both Elaine's and John's statements.
D neither Elaine's nor John's statement.

15c-6 15d Co 4 (c) A

There is a higher proportion of Type V plants on the floor of the valley in any given year. All of the following statements are helpful in explaining this **except** one.

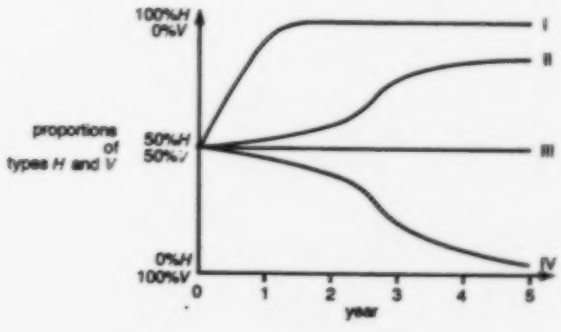
Which statement does **not** help to explain the observation?

A Type H plants are weaker than Type V plants, and so are less likely to survive.
B On the floor of the valley, Type V plants are more likely to be successful in the competition for light.
C In this habitat, ability to withstand dry conditions is not the most advantageous characteristic.
D Type V seeds are likely to germinate on the floor of the valley in greater numbers than Type H seeds.

15c-7 17e An 3 (c) B

Suppose the investigator had mixed equal numbers of seeds from Type H and Type V plants and sowed them in an experimental plot. In subsequent years the plants were allowed to reproduce naturally. Also assume that the conditions were closely similar to the hillsides of the valley where the *Atkinsonia australis* population occurs.

Which of the following graphs represents the most probable results of study of the proportions of the two types growing in the plot over a five-year period?



A graph I
B graph II
C graph III
D graph IV

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15c-8 – Co 3 (c) D *Grevillea* x *gaudichaudii* is a natural hybrid between *G. acanthifolia* and *G. laurifolia* occurring in the Blue Mountains of New South Wales. Populations of the hybrid show a graduation of characteristics ranging from forms closely resembling *G. acanthifolia* to those closely resembling *G. laurifolia*.

In the future *G.* x *gaudichaudii* will be regarded as a distinct species if

A its populations contain identical individuals.

B its parent species become extinct.

C it loses the capacity to be pollinated from adjoining populations of either parent species.

D it ceases to interbreed with either parent species and produce fertile progeny.

INCORRECT response items

15c-9 – Co 2 (i) B Each of the following is an example of adaptation to environment.

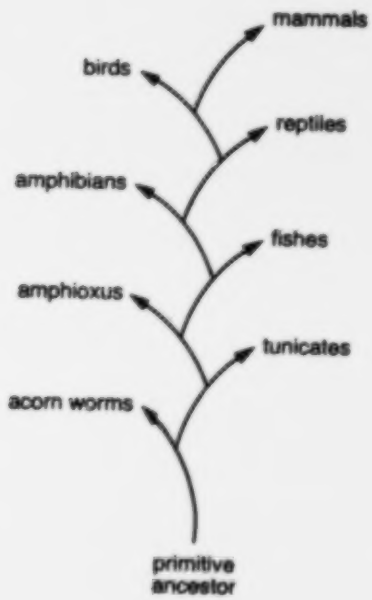
A The light-coloured skin of Europeans in higher latitudes.

B The high rate of incidence of mental deficiency sometimes found in small, remote rural communites.

C The small noses of Red Indians in Canada compared with tribes further south in the USA.

D The high rate of incidence of sickle-cell anaemia in areas of West Africa where malaria occurs.

After examination of fossil evidence, a researcher constructed a diagram to represent a possible phylogenetic tree for chordates.



15c-10 – Co 3 (i) A * The relationships illustrated support the suggestions that

A acorn worms and amphioxus are more alike than acorn worms and tunicates.

B amphioxus appear in the fossil record before fishes.

C the relationship between fishes and amphibians is similar to that between birds and mammals.

D fishes have more characteristics in common with the primitive ancestor than do birds.

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15c-11 – Ap 2 (l) B One of the major medical problems of this century is the speed with which bacteria become resistant to new antibiotics.

For such a bacterial species, the following would always be true.

A The bacteria in the population exposed to the antibiotic have inheritable differences between them.

B A dominant gene controls the mechanism which achieves resistance to the antibiotic.

C The bacterial population is able to evolve in response to a changing environment.

D Resistant bacteria are selected by the new antibiotic.

15d—Survival and changes in populations

CORRECT response items

15d-1 17d Co 3 (c) B Darwin believed that the theory of evolution by natural selection could explain all but one of the following.

Which one could it **not** explain?

A adaptation to environment

B the origin of variations

C effects of selective breeding

D change in a species.

15d-2 – Co 4 (c) A Which one of the following activities is **most** likely to reduce the fitness of the species involved?

A caring for sick and injured individuals

B driving out members of the group when the numbers living together become large

C producing resistant forms when conditions become unfavourable

D the formation of strongly defended breeding territories

15d-3 17k Co 5 (c) D Which one of the following statements is **inconsistent** with Darwin's theory of the mechanism of evolution?

A Present-day organisms have descended from those existing in previous ages.

B Through breeding, new varieties of organisms are continually being produced.

C Living organisms tend to produce larger numbers of offspring than can be supported by the available resources.

D Organisms with characteristics acquired in a particular situation will pass to their offspring a greater ability to survive in that situation.

INCORRECT response items

15d-4 15f Co 2 (l) B In England, two distinct types of the moth *Biston betularia* can be found; a light form and a densely pigmented form. In industrial areas the densely pigmented form predominates and in country areas the light form predominates.

It would be reasonable to explain the distribution of moths as follows.

A The densely pigmented form has a greater survival rate in industrially polluted areas.

B Industrial pollution increases the frequency of mutation of the light form.

C Changes in the habitat caused by industrial pollution cause selection against the light form.

D An increase in industrial pollution resulted in an increase in the predation on the light form.

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15d-5 15l Co 2 (l) A •

The type of barley most commonly grown in Australia at present has a serious defect in that the crop does not 'hold' well in the paddock prior to harvest: any strong wind or excessive heat tends to shatter the ripe heads. Farmers in South Australia frequently 'roll' their crops just before they mature; in this way the plants are bent over so that they lie almost horizontally. They are then less subject to wind damage and later on can be lifted and safely harvested.

Each of the following procedures would contribute to the development of a non-shattering barley variety.

A Grow the best yielding varieties. Roll the crop just before maturity and delay harvesting for at least two weeks.

B Grow barley from all known types of barley and select the plant least subject to shattering.

C Grow the best yielding varieties known. Delay harvesting until after a good wind and harvest only the heads that remain intact.

D Expose young barley plants to X-rays or ultra-violet light and then search for a non-shattering mutant among the survivors.

15e—Environmental effects on population characteristics

CORRECT response items

15e-1 6e Co 1 (c) D

Where a slow and progressive environmental change occurs, a particular population may continue to survive as a result of

A its ability to increase its reproductive rate in adverse conditions.

B its members interbreeding with members of other populations.

C no unfavourable mutations occurring within any member of the population.

D the appearance of inheritable characteristics suited to the changing environment.

15e-2 6f Co 2 (c) B

In a rapidly changing environment a process of succession is often observed: populations of organisms appear, flourish for a time, and are then replaced by populations of other organisms.

The failure of so many populations to continue to survive in such circumstances is most probably attributable to the fact that these organisms

A belong to species with low reproductive rates.

B lack the characteristics necessary to survive in a changing environment.

C are unable to undergo mutation.

D have exhausted the supply of nutrient materials.

15e-3 15c Co 3 (c) A

'There are many varieties of apple today, very different in flavour and size from the small sour fruit of the wild apple.

This is consistent with the hypothesis that

A selection can change the characteristics of a population or a species.

B there has been an evolution from a species whose members were originally identical in all respects.

C evolution of the species depends on mutation.

D each species had its own separate ancestors from the beginning of time.

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15e-4 – Co 4 (c) B Which one of the following is the best explanation for the process of evolution?

A Certain species evolve in a particular direction, often to the disadvantage of the animals concerned.
B Chance variations are subject to a process of selection.
C Natural selection favours those organisms which change their structures to aid survival.
D Characteristics acquired during the lifetime of an individual can be inherited.

15e-5 – Ap 4 (c) B The noted American zoologist A.S. Romer described turtles as 'the most bizarre of reptilian groups'.

> ... if, in the far distant future man in turn disappears from the earth, very likely there will still be found the turtle plodding stolidly on down the corridor of time.

Which statement is an incorrect explanation of the survival of such a conservative group of reptiles?

A Turtles are well adapted to their various habitats.
B Turtles do not need to undergo further changes to survive.
C There is lack of competition between turtles and better adapted organisms.
D Because of their longevity, turtles have a slow rate of evolution.

INCORRECT response items

15e-6 15d Ap 2 (I) A *Camelina sativa* (mustard weed) grows in crops of flax as well as on roadsides and in hedgerows. Usually the weed is a branched, bushy annual producing many small round seeds. In the harvesting process the small weed seeds are removed and a yield of clean flax seeds is obtained. Where the flax has been grown extensively for many years, however, a second variety of *Camelina sativa* is found in crops of flax. It is a tall, unbranched plant (like the flax) and produces few large seeds. These larger seeds are not removed but remain mixed in with the flax seed and so are replanted the following year.

Each of the following contributes to the development of the second variety.

A environmental change
B selection
C mutation
D competition

15f—Mutations provide the raw material for evolutionary change.

CORRECT response items

15f-1 – Co 1 (c) D • In which of the following mammalian cells would a mutation be most likely to have evolutionary significance?

A white blood cells
B nerve cells
C epithelial cells
D sperm-producing cells

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INCORRECT response items

15f-2 – Co 2 (i) C

It has been said that mutations 'provide the raw material for evolutionary change'.

This statement is accurate because mutations

A increase the variability within a population.
B produce disadvantageous as well as advantageous characteristics in the individual.
C significantly increase the frequency of new genes within a population.
D produce new genes which can be passed on to subsequent generations.

15g—The development of new species

CORRECT response items

15g-1 – Ka 4 (c) D

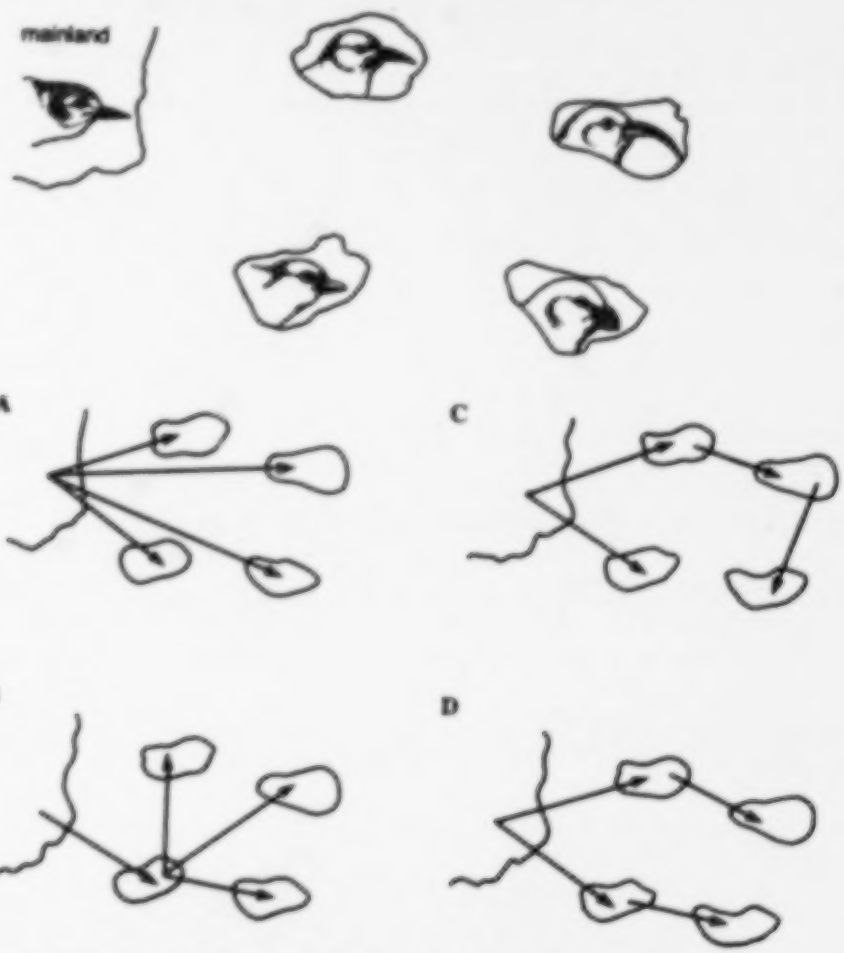
New species are **least** likely to arise through

A genetic engineering by man.
B geographical isolation over many generations.
C gene mutations and natural selection.
D cross-breeding of species under natural conditions.

15g-2 15h Co 3 (c) D

The diagrams below show dispersal patterns of five closely related species of birds on a mainland and four adjacent islands. In each of the five communities only one species is found.

On the basis of beak shape, which is the most likely dispersal pattern?



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15g-3 The general trend of evolution is
15d
Co
2
(c)
B

A the merging of many different types into one uniform group.
B the divergence of types which become adapted to different ecological habitats.
C a direct-line progression from a primitive type to a more elaborate form of the same type.
D the acquisition of new organs as a result of need.

15g-4 Eastern rosellas and pale-headed rosellas are thought to have descended from a bird which had a range extending over much of Australia. Now the range of the eastern rosella extends from Tasmania to southern Queensland and the range of the pale-headed rosella extends from Cape York to northern New South Wales.
–
Ap
4
(c)
D
•

For this situation to have arisen it is probable that

A a mutation occurred in southern Queensland.
B the pale-headed rosella migrated to the snow country.
C for a long period a geographical barrier isolated the northern and southern extremes.
D a cline existed in the past around the entire coast thus allowing variation to occur in the overlapping ends.

15g-5 Pollen from one species of *Eucalyptus* flowering in late autumn may be deep frozen and later thawed and applied to the stigmas of a different but closely related *Eucalyptus* species which flowers in spring. If fertilization occurs and seeds are collected and sown, inter-specific hybrids may be grown.
–
An
2
(c)
C

The evolutionary consequence of the seasonal differences in flowering is the

A production of an adequate and continuous nectar supply for honey-eaters.
B giving to pollen-gathering insects the chance to contribute to the formation of new species of *Eucalyptus*.
C maintenance of both species of *Eucalyptus* in reproductive isolation.
D reduction of demands on soil nutrients for the production of large numbers of flowers.

INCORRECT response items

15g-6 On a certain island a study was made of a species of bird. The bird fed mainly on seeds, since these were abundant, but they also fed on insects. The birds had short strong beaks suitable for crushing the seeds. Some of the birds had somewhat longer and more slender beaks. Then a disease destroyed most of the plants which produced the seeds that the birds had been feeding on. Since the seed was scarce, the birds with shorter beaks began to starve while the birds with longer beaks were able to probe in the ground and in the bark of trees for insects. After many years it was found that the birds on the island had beaks on the average longer than before the plant disease had occurred.
15e
Co
3
(i)
B

Each of the following has occurred in this situation

A natural selection
B formation of a hybrid population
C mutation
D changing environment favouring a particular phenotype

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15h—Convergence, sex differences and mimicry

CORRECT response items

15h-1 – Kn 2 (c) D •

Two populations can be described as different races if, on examination of structure and behaviour, they

A are indistinguishable, and they cannot interbreed.
B are indistinguishable, and they can interbreed.
C can be distinguished from each other, and they cannot interbreed.
D can be distinguished from each other, and they can interbreed.

The next 2 items refer to the following eight characteristics shared by most birds:

I feathered body
II scaly lower limbs
III four-chambered heart
IV light-weight skeletal structure
V warm blood (homoiothermic)
VI reproduction by egg laying
VII nest building
VIII care of young by parents

15h-2 2d Co 1 (c) C

Aldous Huxley has described birds as 'glorified reptiles'.

Which one of the following pairs of characteristics found in birds best supports Huxley's contention?

A II and V
B III and VII
C II and VI
D VI and VIII

15h-3 – Co 2 (c) B

In using the adjective 'glorified', Huxley implied that birds' evolution is more advanced than that of reptiles.

Which of the following characteristics is most indicative of this advance?

A IV
B V
C VI
D VII

INCORRECT response items

15h-4 – Kn 2 (l) B

Variation between individuals in a population would be increased by

A random assortment of chromosomes during meiosis.
B linkage.
C mutation.
D random meeting and fusion of gametes during fertilization.

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15h-5 Each of the following is an example of divergent evolution.

– Co 2 (I) A

A The honeybee (Class Insecta) and the honeyeater (Class Aves).
B The domestic dog (*Canis familiaris*) and the wolf (*Canis lupus*).
C The negroid and caucasoid races of man (*Homo sapiens*).
D Frogs (genus *Rana*) and Toads (genus *Bufo*).

15h-6 'Mutations are the raw material on which Natural Selection acts to affect changes in the phenotypes of subsequent generations.'

– Co 2 (I) C

This statement is correct, provided that

A individuals possessing these mutations produce offspring.
B the mutation in some way contributes to the survival of its possessor.
C the mutation is not located in the gonads of individuals.
D the mutant allele allows normal development of the offspring in the feotal stage.

15h-7 Each of the following features of sharks and dolphins suggests evidence for convergent evolution.

– Co 3 (I) B

A Both are similar shaped acquatic animals.
B The dolphin breathes with lungs while the shark uses gills.
C Both animals are streamlined with well developed fins.
D Dolphins are mammals while sharks are fish.

15h-8 It is common practice to drench sheep for intestinal parasitic worms by orally administering a chemical with a special syringe.

– Ap 4 (I) B

The treatment is only 99 per cent effective and some worms and their eggs survive on the pasture. These have the potential to reinfest other sheep.

Factors explaining the survival of one per cent of the worms would include

A the presence of some worms in the rectum at drenching time.
B the surviving worms developing an immunity to the drench during the pasture phase of their life cycle.
C the sheep drinking copious amounts of water prior to drenching.
D the sheep regurgitating and rechewing their stomach contents soon after drenching.

15h-9 Evidence for evolutionary relationships could be obtained by studying

– Ap 4 (I) B

A homologous structures such as the limbs of vertebrates.
B a comparison of the numbers of individuals in different groups of vertebrates.
C the blood protein of a wide range of organisms.
D fossils in sedimentary rocks.

15h-10 There has recently been concern about the number of feral (wild) cats in Australian bushland. National Park Rangers who shoot these cats often report that the wild cats are generally larger than household pets.

– Ap 5 (I) C

It is presumed that feral cats orginate from strayed or abandoned domestic cats.

That the feral cats generally tend to be larger than their domestic counterparts indicates that

A the diet of the feral cats is better balanced than that of domestic cats.
B smaller cats of mature age do not compete as well in the wild state.
C the genotype of the larger cats will be similar to that of smaller cats.
D larger cats leave more offspring in the wild state than smaller cats.

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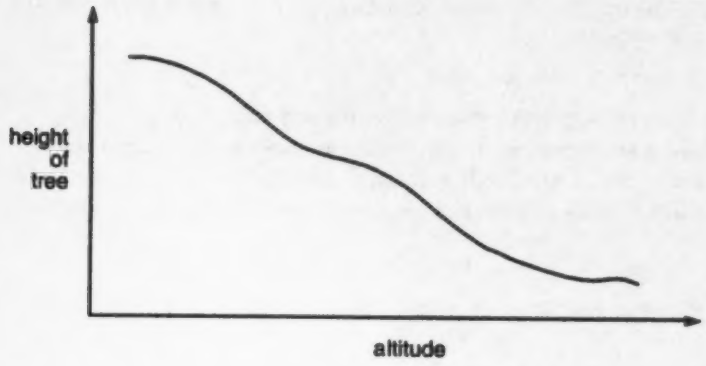
15i—Natural selection changes allele frequencies

CORRECT response items

15i-1 – Ap 2 (c) C *

The following graph shows the relationship between the average height of *Eucalyptus pauciflora* and altitude in a mountain region near Canberra, Australia.



Which of the following statements best accounts for this relationship?

A Mutations have been produced in the trees by the high altitudes.
B Separate gene pools have formed at the different altitudes.
C Different gene frequencies have been produced at the different altitudes.
D Natural selection has been operating to form several species.

15i-2 15d Co 2 (c) A *

After an area was sprayed with the insecticide DDT, it was found that some populations of mosquitoes were resistant to DDT.

The best explanation for this is that

A mosquitoes naturally resistant to DDT are more likely to survive and reproduce.
B DDT causes individual mosquitoes to become resistant to DDT.
C mosquitoes that become resistant to DDT as a result of the spraying produce offspring resistant to DDT.
D DDT acts on a particular gene causing it to produce an enzyme which destroys DDT.

15i-3 – Co 2 (c) A *

Although some alleles produce harmful effects, they are found to persist in a natural population.

All of the following are possible explanations for this **except** one.

Which one?

A Mutant alleles are retained, since they may give individuals an advantage if the environment changes.
B Different alleles may give an advantage to individuals at different times or in different places.
C Even if certain alleles are being lost by selection, they are being produced by mutation.
D Heterozygous individuals may be at an advantage over either kind of homozygous individual.

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15i-4 The frequencies of most alleles in a natural population remain constant from generation to generation.

Co 2 (c) C •

All of the following would cause a change in the frequency of an allele in a natural population except one.

Which one?

A increased selection for one phenotype
B more migration of one phenotype
C a large increase in the size of the population
D one phenotype becoming more likely to have successful matings

INCORRECT response items

15i-5 A major change in habitat of a population will generally lead to a change in

Kn 2 (I) A

A mutation rate.
B gene frequencies.
C selection pressures.
D the phenotype of individuals.

15i-6 In any population of sexually-reproducing individuals within the same species, considerable variation in the phenotype is evident.

Co 1 (I) C

This is because

A environment can affect phenotypic expression.
B there is heterozygosity rather than homozygosity in most allele pairs of the population.
C genotypes of gametes are the same as those of parent cells.
D mutation introduces new alleles into the gene pool.

15i-7 A change in environmental conditions may lead to a change in the frequency of phenotypes in a population because

Co 2 (I) C

A some individuals are better suited to the changed environment than other individuals.
B predators kill off some phenotypes at a greater rate than other phenotypes.
C the different environmental conditions increase the chance of mutation.
D there may be different foods available for some of the individuals thus giving them a better chance of survival.

15i-8 Man has hastened the evolution of grain-producing plants considerably.

Such techniques employed by him could include

Co 2 (I) B

A increasing the gene frequencies of certain desirable alleles.
B allowing cross pollination to occur at random.
C selecting seed from larger plants in a population of mature plants.
D discarding plants that are affected by fungal disease.

15i-9 Biologists can estimate the biological distance between two populations by

Ap 3 (I) D

A measuring the frequencies of alleles in common between the two populations.
B comparing physical features of the two populations.
C measuring the amount of genetic mixing between the two populations.
D comparing selective agents in the two populations.

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15i-10 – Ap 2 (l) A

In Australia, lambs have their tails removed either by cutting with a knife or by constriction with a small, strong rubber ring.

The outcome is that all adult sheep treated in this manner are tailless.

A similar arrangement exists for some dogs such as corgis.

In spite of this radical procedure sheep and dogs continue, without exception, to be born with long tails, even though the practice has been in use for hundreds of generations.

The above observations suggest that

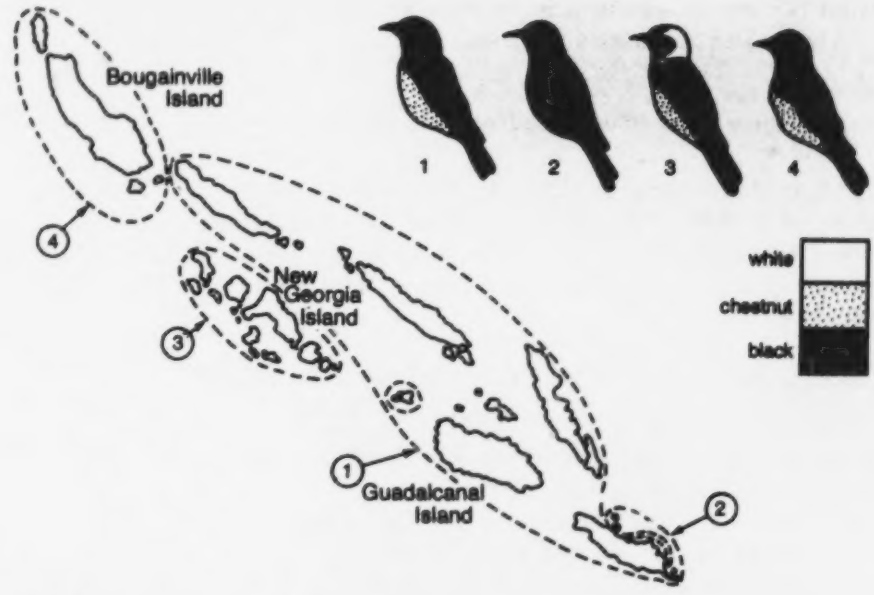
A acquired characteristics bring about new alleles in the gametes.
B environmental pressures can alter the phenotype of an organism.
C long tails in sheep may jeopardise a sheep's survival under Australian conditions.
D any alteration of sheep's tails by natural selection is being hindered by man.

15j—Formation of subspecies and new species by adaptation and isolation

CORRECT response items

15j-1 – Ap 3 (c) B •

The diagram below shows the colour patterns of four subspecies of the flycatcher *Monarcha castaneoventris* and their distributions in the Solomon Islands.



Which of the following best explains the existence of distinctly different colour patterns within this bird species?

A Each subspecies represents a population which is reproductively isolated from the other three.
B Gene flow between subspecies populations is significantly less than gene flow within each subspecies population.
C The environments of the separate islands are significantly different.
D Each colour pattern represents the ideal pattern for the local environment.

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15j-2 In animals, gene flow is the movement of genes from

– Kn 1 (c) C *

A one locality to another.
B one species to another.
C one population to another.
D one cell to another during meiosis.

15j-3 Observations made on spiders on an island showed that all male spiders were structurally similar, but that there were two different mating behaviour patterns. In any cross the male offspring had the same dancing pattern as the male parent and the female offspring of the same cross responded only to that dancing pattern.

– Ap 3 (c) C *

These spiders would best be classified as

A one species.
B one species with two subspecies or races.
C two species in the same genus.
D two species in different genera.

INCORRECT response items

15j-4 Interbreeding of two populations of frogs (Groups I and II) may occur if

– Co 1 (I) C

A they live in close enough proximity for individuals in the two groups to meet.
B the females of Group I are able to recognize the call of the males of Group II.
C hybrid tadpoles become infertile adults.
D the females of Group I lay their eggs at a time when the males of Group II are sexually fertile.

15j-5 Races are sometimes described as a stage in the development of new species.

– Co 1 (I) B

Each of the following conditions would facilitate formation of two new species from two existing races.

A reproductive isolation of members of one race from the other
B interbreeding between members of each race to produce fertile hybrid offspring
C increasing differences between members of each race leading to differing gene pools
D each race tending to be confined to geographical areas with differing environmental factors operating

15j-6 At various different levels down the Grand Canyon, there exist different species of rattlesnakes with distinct differences in marking.

– Co 3 (I) D

It is probable that

A these different species evolved from a common ancestor.
B all these snakes are adapted to their environment.
C access between different levels in the canyon is unlikely for the snakes.
D intermediate types exist between the different levels.

15j-7 The following events would assist in the development of new species from an existing population.

– Co 2 (I) B

A a wide range of anatomical and physiological variation within that population
B an environmental catastrophe or hardship affecting all members of the population to the same extent
C a permanent separation of some members of the population from the others
D different alleles being present in different members of the population

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15J-8 – Co 3 (I) C

David Attenborough in describing the variations in the beaks of birds, in the book 'Life on Earth', outlines the types of honey-creepers found in Hawaii.

> Some have short thick bills for seed-eating, others have hooked and powerful ones for tearing carrion. One species has a long curving bill for extracting nectar from *Lobelia* blossoms; another has an upper mandible twice the length of the lower which it uses to hammer bark and lever it off in search of weevils; yet another has crossed mandibles, a form apparently that enables it to extract insects from buds.

He then goes on to describe the beaks of birds from other regions of the world:

> The sword-billed hummingbird has a probing beak four times the length of its body to suck nectar from the deep-throated Andian flowers. The macaw has a hooked nut-cracker of such strength that it can split the most intractable of nuts, the Brazil nut. The woodpecker uses its beak like a drill to excavate wood-boring beetles.

From these descriptions it is reasonable to propose that

A the honey-creeper extracting nectar from *Lobelia* and the sword-billed humming bird form an example of convergent evolution.

B the honey-creepers of Hawaii constitute an example of divergent evolution.

C the different species of Hawaiian honey-creepers are regarded as forming a common gene pool.

D the diversity of beaks in these birds indicates that together they will occupy different ecological niches in their communities.

15k—Population distributions related to changes in land forms

CORRECT response items

The next 2 items refer to the following information:

The map shows the past and present distribution of a particular family of mammals.

present distribution

I — oldest fossils of this family

IV — most recent fossils of this family

15k-1 17k Co 1 (c) A

From the evidence of the fossil record of this family, it appears that the family probably originated in

A North America.
B South America.
C Europe.
D Asia.

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15k-2 If fossils were found in eastern Asia, they would most likely be
17k
Co
2
(c)
C

A older than type I.
B about the same age as type I.
C about the same age as type II.
D more recent than type II.

INCORRECT response items

15k-3 Lungfish, still found in Australia, could have become extinct in the northern hemisphere because
–
Co
2
(I)
D

A their preferred foods were no longer available.
B the climate became unsuitable.
C they were unable to compete successfully with other forms of fish.
D there was not enough oxygen available in the waters in which they lived.

15k-4 Ratites are flightless, non-swimming birds. The distribution of these ground dwelling birds, in such far away places as South America, Australia, Africa and New Zealand, puzzled scientists for many years. Continental drift is now the accepted explanation for this distribution.
17k
Ap
3
(I)
C

For this theory to remain plausible evidence should exist that

A birds must have been widely distributed before continents broke away.
B other organisms have similar distributions.
C ratite birds differ structurally from flying birds.
D fossil remains of ratites pre-date the break-up and separation of continents.

15k-5 The table below summarizes the number of reptile species found on two island groups, X and Y, found in different regions of the world.
–
An
5
(I)
D

	Island Group X	Island Group Y
Species found only in the island group	17	0
Species found in the island group and elsewhere	0	13

Each of the following island characteristics would account for the data set out in the table.

A Island group Y is a volcanic group of islands which emerged several million years ago and remained isolated from other land masses.
B The reptiles on island group X show divergent evolution from a single ancestral form of reptile.
C The more remote islands of group X have species unique to one island while the islands closer together tend to have examples of several species.
D For reptiles on both island groups some form of isolation has been necessary to explain the speciation.

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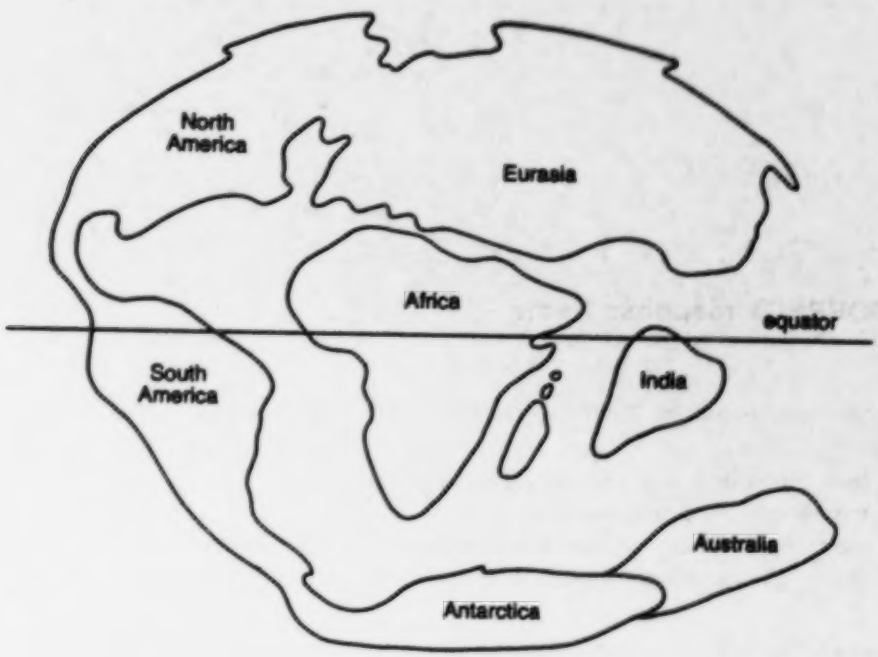
The next 2 items refer to the following information:

The diagram below shows the probable arrangement of the continents at the end of the Mesozoic era.



15k-6 – Co 4 (I) D Marsupials are believed to have first originated in North America, then migrated to Australia via Antarctica.

Evidence to support this theory would include

A finding the oldest marsupial fossil from North America and the most recent one from Australia.

B finding fossils of marsupials in Australia.

C a recent continental drift discovery placing Antarctica between Australia and North America.

D the fact that the greatest diversity of living marsupials is in Australia.

15k-7 – Ap 5 (I) B Reasons for Australia having a more diverse population of marsupials than North America would include

A the relative lack of placental competitors in Australia.

B a more suitable climate in Australia for marsupials.

C the adaptive radiation of marsupials in Australia.

D the isolation of Australia after the arrival of marsupials.

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16 The Human Species

Homo sapiens

16—Human characteristics and their variation

CORRECT response items

16a-1 The list gives some characteristics of the Families Hominidae and Pongidae.

– Kn 4 (c) B *

I stereoscopic vision; II opposable big toes; III opposable thumbs;
IV presence of premolar and molar teeth; V jaw shape.

Which characteristics taken together can be used to distinguish between the two families?

A I and IV
B II and V
C I and III
D I, IV and V

16a-2 A to D are extracts from a scientific paper by W.W. Howells on 'The Distribution of Man'.

17c An 4 (c) B

After reading the extracts, each of which refers to a human characteristic, indicate which one gives **least** support to the hypothesis that human racial characteristics have adaptive significance.

A Steatopygia. A characteristic possessed by adult females of the Hottentots—a tribe living in the Kalahari desert of South Africa. During a good season these women accumulate a surprising quantity of fat on their buttocks (a mechanism reminiscent of the camel's hump). It is a storehouse of fat that is not distributed over the body generally, where it would be disadvantageous in the hot climate of the Kalahari.

B Dark skin. This characteristic is due to melanin which screens out some of the sun's rays and eliminates most of the effects of the harmful ultra-violet light. The dark-skinned pygmies of Africa live in dense tropical forest. The Hottentots have light yellowish-brown skin and live in open sunny country.

C Eye fold. The 'almond' eyes of Mongoloids are deeply set in protective fat-lined lids. The nose and forehead are flattish, the cheeks broad and fat-padded. Such a face is an ideal mask to protect eyes, nose, and sinus against bitterly cold weather. These features are most marked in the cold north-east part of Asia, from Korea northwards.

D Light skin. The Caucasian humans of the northern part of Europe are light-skinned, with a minimum of melanin. The amount of ultra-violet in the little available sunlight in their cloudy climate is beneficial to humans. Towards the sunnier Mediterranean region, the Caucasian skin is darker.

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The next 2 items refer to the following information:

The diagrams show a series of primate skulls.

16a-3 – Kn 3 (c) D

Which one of the following characteristics is **least** important in distinguishing a hominid skull from other primate skulls?

A eyebrow ridge
B protruding jaw
C relatively small brain case
D presence of incisor teeth

16a-4 – Co 2 (c) A

A group of anthropologists have arranged the skulls in what they believe to be an evolutionary sequence, with *Homo sapiens* represented by diagram IV.

Making the assumption that this sequence is correct, which one of the following hypotheses about the evolution of *H. sapiens* is **least** well illustrated by the skulls?

A Evolution of *H. sapiens* has resulted in an improvement in stereoscopic vision.
B Evolution of *H. sapiens* has involved a reduction in the relative size of face.
C Evolution of *H. sapiens* has involved an increase in the relative size of the brain case.
D There has been a reduction in size of the eyebrow ridge during evolution of *H. sapiens* .

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INCORRECT response items

16a-5 – Co 4 (I) A

Some anthropologists have dubbed *Homo sapiens* 'The Naked Ape' because of the sparsity of hair compared to the other primates.

This could have come about as an adaptation to

A living in regions with a high incidence of solar radiation.
B swimming, as *H. sapiens* is one of the few primates who naturally swims.
C reducing the number of parasites on the skin.
D enhancing heat loss by evaporative cooling.

16a-6 – Ap 3 (I) C •

Two tribes of *Homo sapiens* each living at sea level in quite distinct areas, and each isolated from other tribes are about to be investigated by an anthropologist. The tribes have been isolated for thousands of years during which time climatic conditions have remained unchanged.

Tribe A lives in an open, hot desert region.
Tribe B lives in a cold, sub-Arctic region.

The anthropologist would be reasonable in predicting that, as a result of selection,

A the mean limb length of Tribe A people would be greater than that of Tribe B people.
B there would be no significant difference in the mean size of the cerebral hemispheres in people of Tribes A and B.
C the mean ratio of body surface area to volume of Tribe A people would be less than that of Tribe B people.
D the skin pigmentation would be lighter in Tribe B people than in Tribe A people.

16a-7 – Ap 3 (I) D •

People who live in Arctic regions are generally able to withstand very low temperatures better than people who live in temperate regions.

One could reasonably predict that

A if this trait is under genetic control, then people who live in Arctic regions would have offspring who also show the trait.
B if this trait is under genetic control, then an adult born and reared in Arctic regions would continue to show the trait if he moved to a temperate region.
C if this trait is acquired, people who previously lived in Arctic regions but have shifted to temperate regions would have offspring who do not show the trait.
D if this trait is acquired, then an adult who previously lived in Arctic regions would continue to show the trait if he moved to a temperate region.

16b—Human origins and fossil evidence

CORRECT response items

16b-1 – Kn 1 (c) A •

One characteristic that humans do **not** share with the other anthropoids is

A legs longer than arms.
B opposability of the first digit of the hand.
C stereoscopic vision.
D the ability to use tools.

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16b-2 – Co 1 (c) B •

Fossil remains of ape-like people and prehistoric people, have been found in various parts of the world—e.g. *Ramapithecus*, *Australopithecus africanus*, *Homo erectus*. There are various hypotheses concerning the relationships of these primates to *Homo sapiens*.

Which one of the following is not one of the current hypotheses?

A These fossils represent prehistoric populations, all of which could have contributed to the gene pool from which *Homo sapiens* arose.

B These fossils represent primate types which arose and became extinct before man's ancestors evolved.

C The fossils represent separate populations which were contemporaries of the ancestors of *Homo sapiens*.

D Any or all of these fossils belong to primate groups which could be ancestors of *Homo sapiens*.

16b-3 – Co 2 (c) C •

If you could go back through the ages in a time-ship, exploring the surface of the earth as you go, how far back would you have to go before you would have a good chance of finding hominids other than *Homo sapiens*?

A 5000 years
B 50 000 years
C 500 000 years
D 5 000 000 years

16b-4 – Co 3 (c) C •

Consider the following list of characteristics:

I reduced sense of smell
II hindlimbs shorter than forelimbs
III presence of body hair
IV opposable digit on both limbs
V forelimbs shorter than hindlimbs
VI opposable thumb only
VII presence of nails instead of claws
VIII presence of forward directed eyes
IX teeth of four distinct types.

It would be reasonable to state that the

A presence of III, V and IX is sufficient evidence to permit classification of a mammal as a member of the Order Primates.

B presence of I, III, VII and VIII is sufficient evidence for classification of a mammal as a member of Family Hominidae.

C members of Family Pongidae possess II, IV and IX.

D members of Family Hominidae possess IV, V and IX.

16b-5 – Ap 3 (c) C •

Fossil remains of two organisms belonging to the same species (X) were found in a particular area. These fossils, denoted X_1 and X_2, each comprised a skull, a jawbone, several vertebrae and a femur, and were shown to be the same age. Tools found in association with fossils X_1 and X_2 were similar to tools found at a distant site in association with fossil Y, an organism of a different species.

The following inferences are valid.

A Organisms of the type represented by fossil X_1 and X_2 would only have lived in the areas in which these two fossils were found.

B The femur length and cranial capacity of fossil X_1 would be identical with those of fossil X_2.

C If species X evolved from species Y then these two species would possess some similar structural characteristics.

D Species X and Y probably evolved from a common ancestor.

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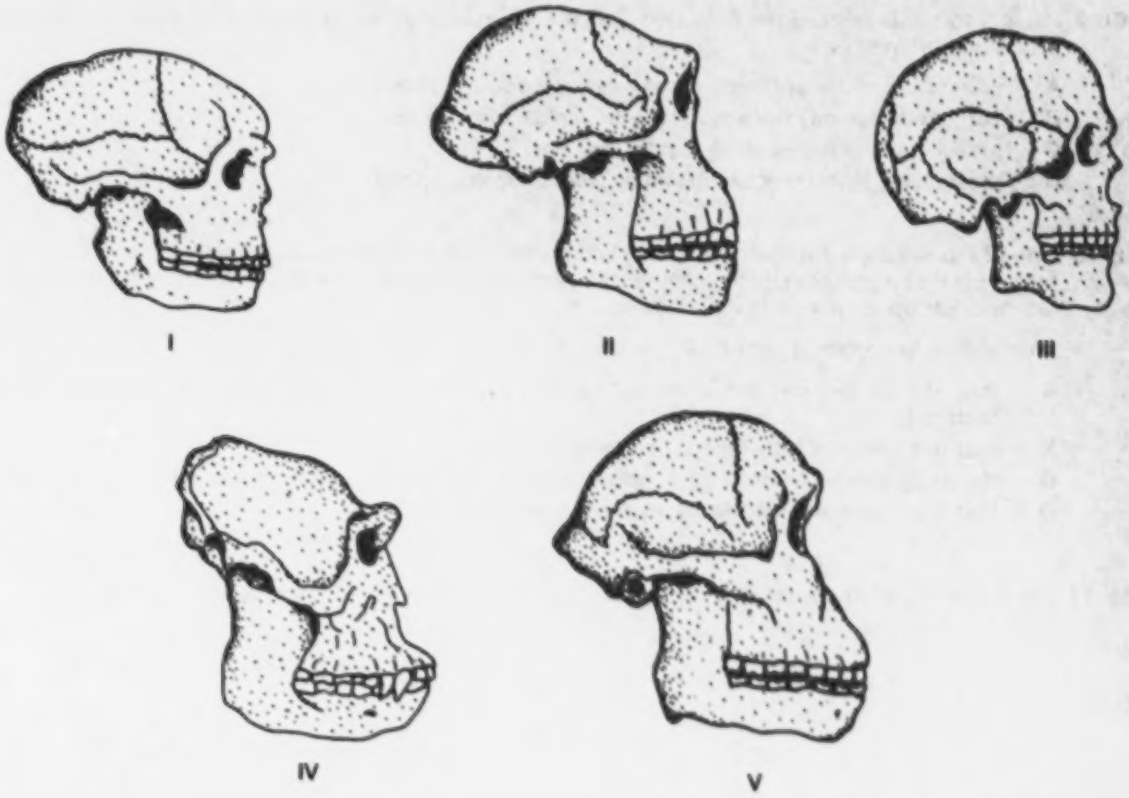
16b-6 Reconstruction of fossil remains have suggested the following shapes of the skulls of *Homo sapiens* and his ancestors.

–
Kn
1
(I)
A



I II III

IV V

The following interpretations can be made.

- **A** Skull I is that of *Homo sapiens*.
- **B** Skull V precedes Skull II in the evolutionary line.
- **C** Skull IV is that of a gorilla.
- **D** Skull II precedes Skull III in the evolutionary line.

16b-7 The fossil record indicates that

–
Kn
4
(I)
C

- **A** monkeys, apes, and *Homo sapiens* have a common ancestor.
- **B** primates were one of the earliest groups of mammals to evolve.
- **C** *Homo sapiens* evolved after apes and from an ape.
- **D** *Homo sapiens* did not evolve from a monkey.

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16b-8 – Kn 2 (I) C

Physical characteristics that distinguish *Homo sapiens* from earlier forms of the Family Hominidae are

A a very large brain case.
B a small face.
C an opposable thumb.
D small teeth.

16b-9 – Kn 2 (I) D

Palaeontologists believe the following primate groups are arranged in order of appearance in the evolutionary time scale.

A prosimians, early anthropoids, monkeys, modern humans
B early anthropoids, monkeys, early hominids, *Homo erectus*
C prosimians, monkeys, *Australopithecus*, *Homo*
D prosimians, *Homo erectus*, *Australopithecus*, *Homo sapiens*

16b-10 – Co 1 (I) D

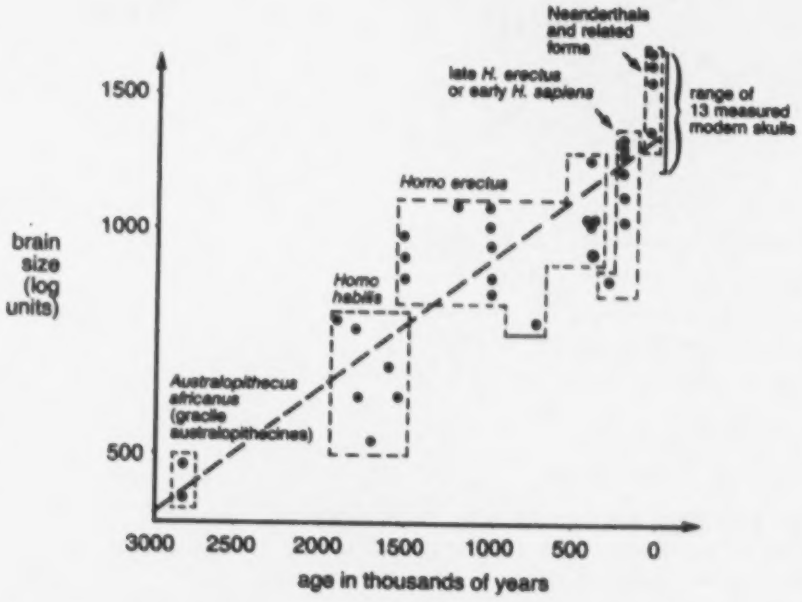
One of the more recent discoveries involving prehistoric hominids are 3.5 million year old hominid footprints that were set in fresh volcanic ash. After the footprints were made, falling rain solidified the ash and left the prints as lasting fossils.

From these footprints, a group of scientists would be able to ascertain

A the age of the deposit from radioactive isotope dating and therefore the age of the footprints.
B that the gait was fully bipedal and erect.
C the approximate height of the individuals who walked 3.5 million years ago.
D that the hominids used tools, as their hands were free.

16b-11 – Co 5 (I) A

The graph shows the change in brain size with time in the Family Hominidae.



In reference to the graph and to what you know of human evolution it could be concluded that

A the brain of *Homo sapiens* is larger than the brain of any other hominid.
B the brain size of these hominids increased gradually with time.
C an increase in body size could account for much of the increase in brain size.
D *Homo habilis* and *Homo erectus* may have existed at the same time.

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16b-12 A hominid can be distinguished from an ape by

–
Kn
2
(I)
B

A facial feature differences.
B presence of an opposable thumb.
C pelvic feature differences.
D skeletal proportions and posture.

16b-13 Before the arrival of hominids, native primates were established in

–
Kn
2
(I)
A

A Australia.
B Africa.
C South America.
D Asia.

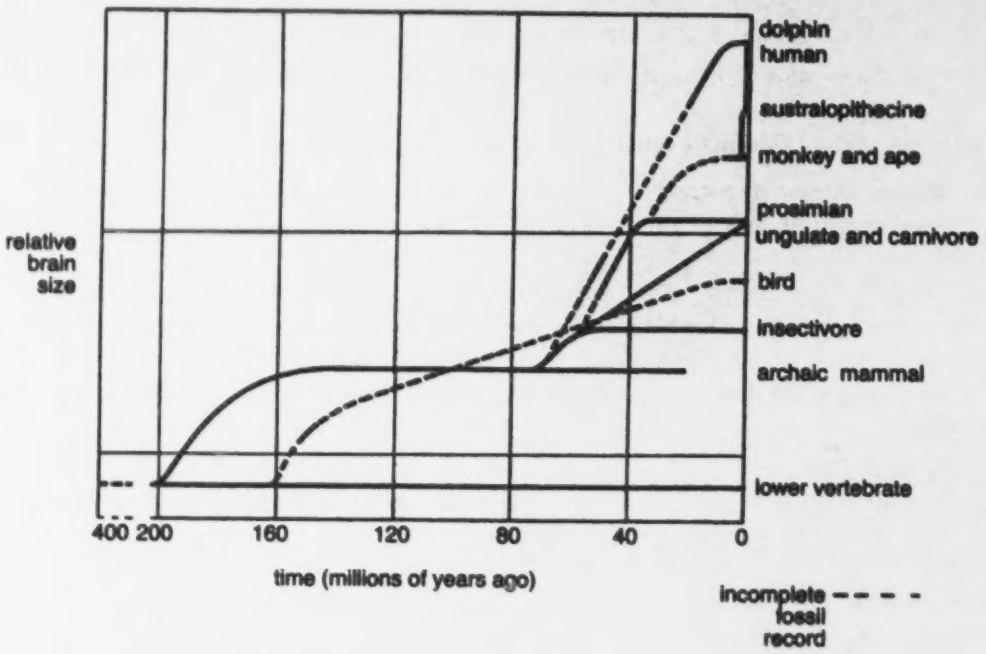
16b-14 *Homo erectus* is believed to have

–
Kn
3
(I)
C

A used tools.
B had pronounced ridges over the eyes.
C diverged from the main evolutionary stream of hominids.
D had a brain smaller than that of *Homo sapiens*.

16b-15 The graph shows the changes in relative brain size with time in a number of vertebrate groups.

–
Ap
4
(I)
B



From the graph it can be concluded that

A the hominid brain has undergone the most rapid rate of expansion in relative size.
B the relative brain sizes of monkeys and apes will not increase.
C existing dolphins and humans have roughly equal relative brain sizes.
D birds have left the most incomplete fossil record.

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16b-16 Archaeologists believe the first hominids in Australia
–
Kn
4
(I)
D

A entered Australia from the north west.
B should be classified *Homo sapiens*.
C must have travelled over water.
D should be classified *Australopithecus*.

16b-17 When comparing fossil remains of modern humans to ancestors since the divergence of *Australopithecus*, the following characteristics would be important in determining their evolution.
–
Co
2
(I)
D

A possession of teeth of a herbivore or a carnivore
B shape of the skull
C volume of the brain cavity
D possession of stereoscopic vision

Science and Society

16c—Human cultures result from learning and communication

CORRECT response items

16c-1 The cultural evolution of humans during the last 50 000 years has been rapid because of several factors.
–
Co
1
(c)
A

Which one of the following is **least** likely to be one of these factors?

A changes in gene frequency
B development of agriculture
C development of a written language
D changes in technology

16c-2 Suppose you had travelled back more than 5 000 000 years, and are returning to the present day.
16b
Co
2
(c)
D
*

At which one of the following times would there be **no** chance of finding primates in a stone age culture?

A the year 1980
B the year 5000 B.C.
C the year 50 000 B.C.
D the year 5 000 000 B.C.

16c-3 Cities could **not** develop until
–
Co
3
(c)
B

A tools were first used.
B agricultural production exceeded local requirements.
C humankind began to grow crops and to domesticate animals.
D agricultural ecosystems were first developed.

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INCORRECT response items

16c-4 17n Co 2 (I) D

The technological progress of humans in the past 10 000 years has accelerated much more than in the previous 4 000 000 years.

This has been due to

A the acquisiton of speech and language.
B the increasing complexity of human social systems.
C the ability to write down knowledge, enabling its accumulation.
D the increasing size of the human brain.

16c-5 – Ev 3 (I) D *

Each of the following statements is a valid comparison between biological and cultural inheritance.

A The major vehicle of biological evolution is the gene, whereas the major vehicle of cultural evolution is the written or spoken word.
B Individuals may acquire their cultural heritage from any source; their biological heritage is received via their parents.
C Biological and cultural evolution have both contributed to the ability of humans to survive in their environment.
D Characteristics acquired during a generation can be transmitted to the next generation both culturally and biologically.

16d—Scientific approaches to problem solving; technology

CORRECT response items

16d-1 17f An 2 (c) A *

An agricultural scientist studying the relation between nitrogen in the soil and the plant growth of a particular species produced the following table:

	% N in soil	% N in plants
Soil X	0.06	1.28
Soil Y	0.36	1.22
Soil Z	0.56	2.51

The best conclusion to be drawn from these figures is that

A the particular plant in question would grow best in soil Z.
B plants in soil X are of less value to the study than plants in soil Y.
C the nutrient content of the soil is reflected in the nutrient content of the plants.
D soil X will lose most of the remaining nitrogen within a short time.

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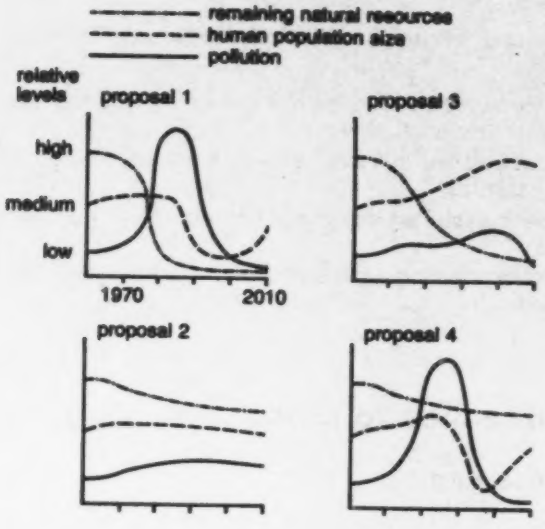
The next 2 items refer to the following information:

Scientists have become increasingly concerned about the future of the world. A group in the US programmed a computer with four sets of possible information to see what predictions could be made about the human population if certain things were assumed to happen from 1970. These scientists, in their four proposals, made various assumptions about:

—remaining natural resources
—human population size
—pollution.

The computer produced the following four graphs, depending on which assumptions were made.



16d-2 17g An 4 (c) B *

The assumption that an effort would be made to control human population rise and environmental pollution probably corresponds with proposal

A I.
B II.
C III.
D IV.

16d-3 17g An 4 (c) C *

The proposal in which present trends were assumed to continue with relatively minor changes was probably

A I.
B II.
C III.
D IV.

INCORRECT response items

16d-4 – Kn 2 (l) A

In analysing the relationship between science and technology, evidence could be given for the assumption that

A science is the application of technological knowledge.
B science depends on technology.
C technology depends on science.
D technology is the application of scientific knowledge.

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16e—The effects of science and technology on culture and the biosphere

CORRECT response items

16e-1 17g An 3 (c) C

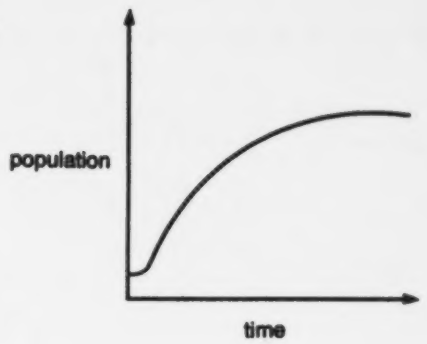
Malthus, in his article 'Essay on the Principle of Population' put forward two major ideas:

I human populations tend to increase in size geometrically, yet their food supplies seem to increase arithmetically;

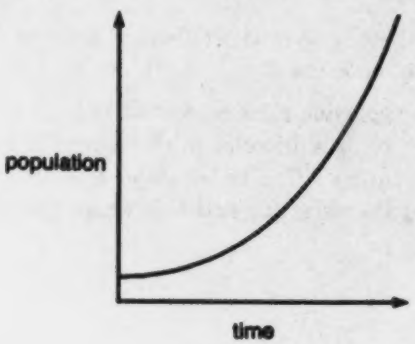
II the human population is kept in check by famine, disease or war.

Which of the following hypothetical population graphs does not support both of these ideas?

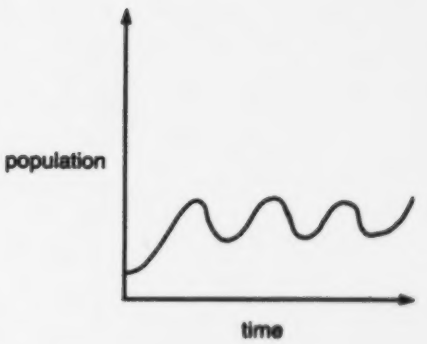
A



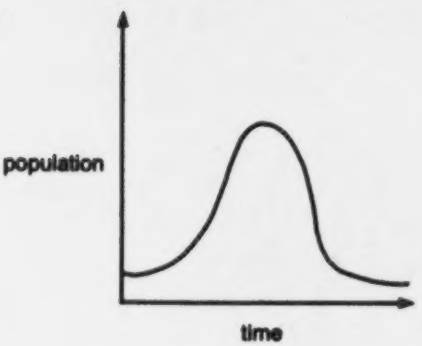
C



B



D



INCORRECT response items

16e-2 – Co 2 (i) A *

As humans gain greater control over their environment their further evolution will

A cease as natural selection no longer operates.

B change from its previous direction.

C still be affected by mutation and reproductive rates.

D still depend on variation among the human population.

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16f—The effects of applying scientific knowledge to human problems

CORRECT response items

16f-1 Future evolutionary changes in humans are likely to be in a different direction from those of the
15e past because
Co
2
(c)
C
•

A natural selection now favours abilities other than hunting.
B radioactive fallout has significantly increased the mutation rate.
C their increasing control of their environment decreases the effects of natural selection.
D the various races are now no longer reproductively isolated.

16f-2 In which one of the following activities is humankind **least** likely to influence the evolution of
– other organisms?
Ap
2
(c)
C
•

A spraying gardens with DDT
B using antibiotics in the control of human disease
C using ^{14}C in radiocarbon analysis
D breeding rust-resistant wheat varieties

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16f-3 17n Co 2 (I) B

It has often been said that the development of science, and the growth of scientific knowledge, over the past 300 years has led to achievements which in many cases have been to the detriment of society and in some cases have threatened human existence. Out of concern for the issues raised by the results of scientific enterprise, several British scientists in 1989 formed a group known as the *British Society for Social Responsibility in Science*. This group argues that 'the development of science is not predetermined but should depend on the social choices of the community'.

The following points are consistent with this argument.

A The development of science is affected more by political, economic and social pressures than by the aims and objectives of individual scientists.

B The development of science should depend more on recent discoveries and achievements than on the theories and principles established in the past 300 years.

C Scientists should become aware of the social significance of science and of their social responsibilities.

D The public should be made more aware of the implications and consequences of scientific development.

16f-4 – Ap 1 (I) D

In conducting a particular experiment investigating ESP (Extra Sensory Perception) in humans, a scientist would accept evidence of its existence if

A there were mechanisms to explain ESP.

B a number of people investigated seemed to have ESP.

C previous results in a similar experiment were reliable.

D chance was a sufficient explanation of the data.

16f-5 – Ap 3 (I) C

A company plans to establish a uranium enrichment plant on the boundary of a National Park. The government appoints a team of biologists to investigate the ecological consequences of the proposal. Their report will partly determine whether or not the project will proceed.

The biologists could reasonably consider the following factors when preparing their report for the government.

A A prediction of the long-term effects of the project on the distribution, abundance and movement of local bird and animal species.

B Results of other studies on the ecological effects of establishing similar industry in other parts of the world.

C Data to determine whether any losses caused by interference to the environment would outweigh the socio-economic gains from the project.

D Findings of field investigations to show the interdependence of organisms within and around the National Park boundary.

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17 Science and the Scientific Process

Note: This section contains only those items which, by their content, cannot be placed in sections 1–16.

All concept area headings for this section are given to enable reference from other sections.

17a—Science as a part of human culture

(see sections 8e, 8f, 16c, 16d)

How a Scientist Works

17b—Apparent relationships may be found between observations

17c—Questions are posed, observations made, data collated and compared

17d—Hypothesis, predictions, experimental design to test hypothesis

INCORRECT response items

17d-1
17e
Ev
2
(I)
C

A biologist is given the task of determining the cause of a certain disease in a population of native Australian hopping mice.

The following would be acceptable ways of conducting a research investigation into this problem.

A Carry out a preliminary study on the mice in their natural habitat in order to define a research hypothesis.

B Consult scientific journals and attempt to reproduce the results of previous related experiments.

C Reject experimental or observational evidence which does not support a particular hypothesis under investigation.

D Conduct a series of suitably controlled experiments, to eliminate variables not suspected of causing the disease.

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CORRECT response items

The next 2 items refer to the following experiment:

Four identical portions of a pure starch solution are put in each of four test-tubes and saliva is added. A small sample of each solution is immediately taken and tested for starch and maltose. The test-tubes are then put into water baths at 0 °C, 20 °C, 40 °C, and 100 °C respectively. Two drops of each mixture are then removed every four minutes to test for the presence of starch and maltose. The results are tabulated below.

temperature	maltose									starch								
	minutes									minutes								
	0	4	8	12	16	20	24	28	32	0	4	8	12	16	20	24	28	32
0°C	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20°C	−	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−
40°C	−	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−
100°C	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

+ indicates that the test is positive

17e-1 From the above results it can be concluded that

17d Co 2 (c) B •

A saliva contains maltose.

B saliva is involved in the conversion of starch to maltose.

C the conversion of starch to maltose cannot occur at 0 °C.

D all of A, B, and C apply.

17e-2 The best explanation for the maltose in the tube at 100 °C is that

17d Ap 2 (c) C •

A the temperature of the water bath has not quite reached 100 °C.

B starch is unstable at 100 °C.

C some starch is converted to maltose before the tube contents reach 100 °C.

D the reaction starch ——————→ maltose proceeds independent of temperature.

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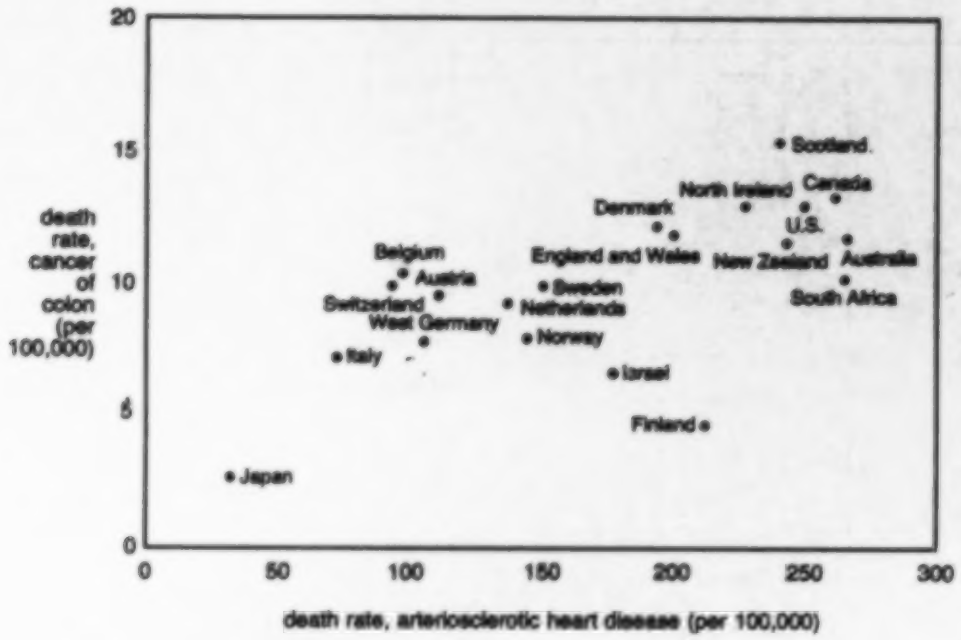
17e-3 17d Ap 3 (c) A Which of the following statements best describes the relationship between a hypothesis and an experiment?

A Results from an experiment may give support to a hypothesis.
B An experiment is designed to prove whether a hypothesis is correct or incorrect.
C The results of an experiment are needed for a hypothesis to be formed.
D A hypothesis cannot be formed unless experimental evidence is available.

17e-4 17f An 5 (c) A The graph shows the correlation between death rates for cancer of the colon and arteriosclerotic heart disease.



The information given in the graph suggests that

A Australians are more likely to die from cancer of the colon than are South Africans.
B both diseases are geographically determined.
C Austrians have twice as much chance of dying from arteriosclerosis as have Finns.
D more people die fron arteriosclerosis in Finland than in Japan.

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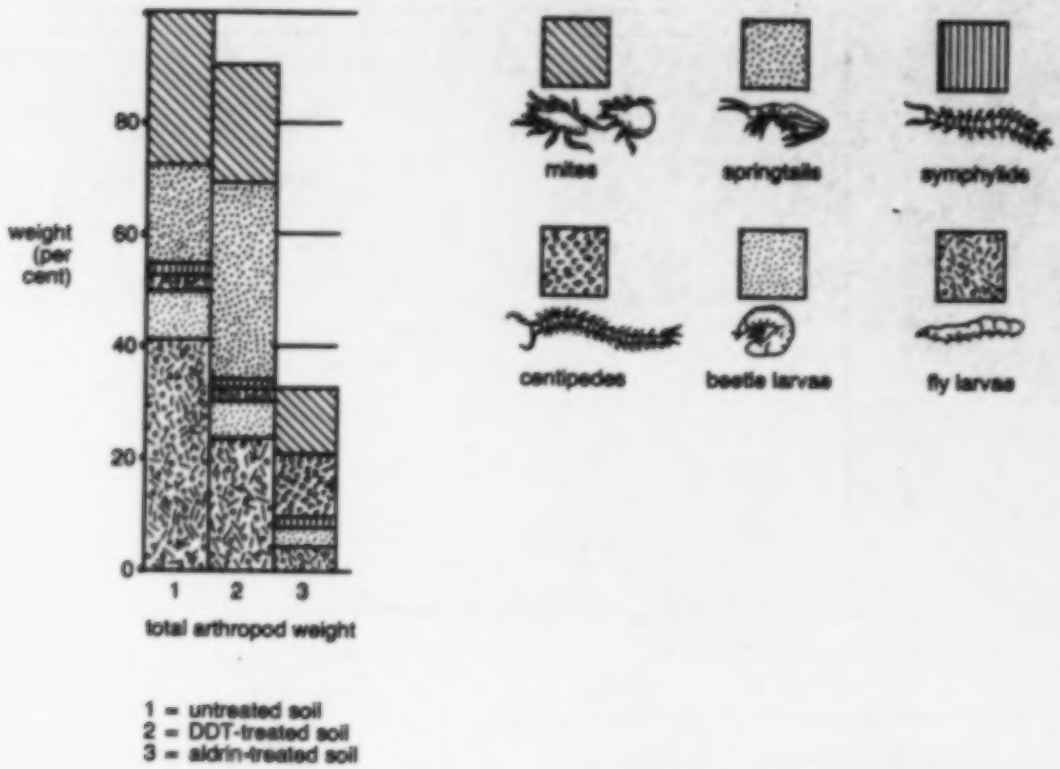
INCORRECT response items

The next 2 items refer to the following information:

A study of the effects of insecticides on certain soil arthropods was made over a period of one year. The animals studied are indicated in the key beside the graph. The first of the three columns shows the average weight in untreated soil of the animals listed (expressed as a percentage of the whole); the second column shows the weights in soil treated with standard doses of the insecticide DDT; the third column is for soil treated with another insecticide called aldrin.



17e-5 17f Co 1 (i) A *

Each of the following animals is significantly affected by treatment with aldrin.

A symphylids
B mites
C fly larvae
D centipedes

17e-6 17f Co 3 (i) B *

Study the effects of the two chemicals on the total weight of soil arthropods.

Each of the following is true.

A All of the kinds of arthropods shown survive dosage with DDT, but centipedes cannot tolerate aldrin.
B The total weight of beetle larvae in the DDT-treated soil is more than in untreated soil.
C The proportion of springtails in the DDT-treated soil is greater than the proportion in the untreated soil.
D The weight of fly larvae is reduced from approximately 40 per cent of the original population to 15 per cent of the aldrin-treated population.

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The Scientist in the Scientific Community

17g—Development and use of appropriate tools and techniques

CORRECT response items

17g-1 – Kn 1 (c) D

A student using a microscope located a slowly moving microorganism in a sample of pond water. He noticed that, as it moved along, the outline of the organism was sometimes quite clear and at other times quite blurred.

The most likely explanation for this is that

A the focusing mechanism of the microscope was faulty.
B the intensity of the light falling on the mirror was fluctuating.
C some of the pond water had been accidentally transferred onto the objective lens.
D the organism was travelling at slightly varying depths in the water film.

17g-2 – Kn 1 (c) A *

In terms of the size of objects being viewed and the resolving power available, which one of the following statements is correct?

A Some cells can be seen with the naked eye.
B The light microscope can be used to observe the internal structure of chloroplasts.
C The structure of cell membranes can be seen by using a light microscope.
D Electrons can be seen with the electron microscope.

17g-3 – Kn 2 (c) A

Which of the following techniques could be used to separate a particular protein from a mixture of cell contents?

A chromatography
B staining
C electron microscopy
D autoradiography

17g-4 – Kn 3 (c) B

Many techniques have been developed to detect the presence of bacteria and study details of their structure.

Which one of the following would be **least** likely to help the biologist to observe an **individual** bacterium?

A Use an electron microscope with a magnification of 100 000 diameters.
B Observe a colony of bacteria on nutrient agar in a petri dish a with stereomicroscope.
C Put a drop of oil on the coverslip and view some bacteria using the oil-immersion lens of a monocular light microscope.
D Smear a slide with bacteria, stain with crystal violet, and view through the high power objective lens of a monocular light microscope.

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The next 2 items refer to the following information:

A student set up a microscope with a 10x ocular lens and a 20x objective lens in position.

17g-5 – Co 1 (c) C

A specimen viewed through this microscope would be magnified by a factor of

A 10.
B 30.
C 200.
D 1000.

17g-6 – Co 3 (c) B

The student then replaced the 20x lens with a 40x lens.

Compared with the original field of view, the new field of view would be

A the original diameter.
B the original diameter.
C twice the original diameter.
D four times the original diameter.

17g-7 – Co 3 (c) A

A student used a microscope to examine some pond water. With one of the objective lenses in position the student measured the field diameter as 1.2 mm. The magnification was 50 X. When using the second objective lens the magnification obtained was 300 X.

What would be the field diameter when using the second objective lens?

A 0.2 mm
B 1.2 mm
C 3.6 mm
D 7.2 mm

INCORRECT response items

17g-8 – Kn 4 (l) A

A transparent organism is to be viewed live under the microscope.

This would be aided by

A staining the organism with iodine
B adjusting the condenser
C using a heat filter
D partially closing the iris diaphragm

17h—Internationally accepted names, symbols and units

17i—Reports assist with accurate communication

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17j—Publication: a record for dissemination, inviting scrutiny and duplication

INCORRECT response items

17j-1
17n
Ev
3
(I)
B

Consider the following statement:

> Scientific research cannot be considered complete until it has been published or otherwise made available for appraisal by the scientific community.

The main implications arising from this statement are that

A results of scientific work need to be made public to overcome the bias and distortion of individual judgment.

B any objections to a hypothesis are overcome once it has the support of other scientists.

C new discoveries, no matter how controversial, ought to be published in order to stimulate further research and scientific debate.

D the existing climate of scientific opinion is able to influence the direction of future research.

17k—Scientific ideas: acceptance, predictability, re-examination

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The Scientist in Society

17l—Awareness of the consequences of investigations

17m—Some issues are beyond the limits of science

CORRECT response items

17m-1 – Ap 2 (c) C

The procedures of science can be used to answer many questions, but there are some issues for which scientific activity is inadequate.

Which one of the following questions could be resolved by scientific procedures?

A Should a dam be built in a particular national park?
B Did birds evolve from reptiles?
C Is green light better than red light for growth of broad beans?
D Should the money for scientific research be increased?

INCORRECT response items

17m-2 – Co 1 (l) D

It has been argued that Australians should not spend money on scientific research, but rather should wait until this knowledge becomes available from overseas.

The following statements are arguments **against** this notion.

A Much scientific research conducted in Australia concerns uniquely Australian problems.
B Australia has a contribution to make towards the common body of scientific knowledge.
C Scientific research in Australia contributes toward a better life for Australians.
D Scientific research uses money which should be spent on more urgent needs in Australian society.

17n—Science and its effects on culture and the biosphere

(see sections 8e, 8f, 16c, 16d and 16e)

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Acknowledgments

- Annual Reviews Inc., California, for extract from article by M. Kleiber in *Annual Review of Physiology*, Vol. 29, 1967.
- Australian Academy of Science, Canberra, for the extract from 'Camel Filters', in *Biology in Action* No. 3, March 1982, and illustrations from *Biological Science: The Web of Life*, 3rd Edition, 1981.
- William Collins Sons & Co. Ltd, London, for two extracts from *Life on Earth: A Natural History* by D. Attenborough, 1979.
- Mr Colin Drake, Elizabeth Matriculation College, Hobart, for the diagram adapted from his class worksheet.
- William Heinemann Publishers, London, for illustration adapted from *Biology of the Mammal* by A.G. and P.C. Clegg.
- i.p.c. magazines for illustration from 'The Evolution of Man' by C. Stringer, in *New Scientist*, 94, 1301, 15 April 1982.
- Macmillian Publishing Co. Inc., New York, for illustration from *Biology of Life* 2nd Edition, 1974, by J.E. Rahn.
- John Murray Ltd, for the graph from *Life Study—A Textbook of Biology* by D.G. Mackean, 1981.
- Thomas Nelson & Sons Ltd, Surrey, for the illustration from *Animal Behaviour* by A.P. Brookfield, 1980.
- W.W. Norton and Coy Inc., for the graph adapted from *Ethology: The Mechanisms and Evolution of Behaviour*, by J.L. Gould, 1982.
- Oxford University Press, London, for tables and diagrams from *The Life Forms of Plants* by C. Raunkier, 1934, and for the illustration from *Biology*, by B.S. Beckett.
- Pergamon Press (Aust) Pty Ltd, Rushcutters Bay, NSW, for illustrations adapted from *Biology Outlines for Senior High School Students* by Wessen & Bates, 1976.
- Harcourt, Brace, Jovanovich Inc., New York, for the illustration adapted from *Life: An Introduction to Biology* by G.G. Simpson, 1957.
- Scientific American Inc., New York, for the graphs from 'Paleontology and the Evolution of the Mind' by H.J. Jevison, in *Scientific American* 234, 1, January 1976, and from 'The Origin of Atherosclerosis' by E.P. Benditt in *Scientific American* 236, February 1977.
- Victorian Department of Agriculture, for the illustration from 'Hydatid Disease: A Vicious Circle that you can Break' by P.J. Jackson in *Journal of Agriculture*, Victorian Agriculture Department, August 1971.
- Williams and Wilkins Company, Baltimore, for extract from 'Transmission and Block in Autonomic Ganglia', *Pharmacological Review* 6, 65, 1954.
- Senior Secondary Assessment Board of South Australia, for inclusion of the following items from the Matriculation Biology Examination papers (Year: Question No):

  1975: 11,15,19,27,33,40,47. 1976: 12,29. 1977: 2,11,16,31.

  1978: 9,21,45. 1979: 5,9,10,40. 1980: 39. 1981: 26.
- Victorian Institute of Secondary Education, for inclusion of the following items from the Higher School Certificate Biology Examination papers (Year: Question No—Item No):

  1975: 1–30; 4–3,4; 9–3,4,5,6.

  1976: 1–12,27,30,31,32,33,34,35; 2–4,5,6; 4–5,6; 5–2,3,5,6,7.

  1977: 1–18,24,34; 2–1,4,6,7; 5–2,3,7; 7–1,2.

  1978: 1–23,34.

  1979: 1–12,19,27,31,37.

  1980: 1–20.

  1981: 1–23.
- Tertiary Institutions Centre, WA, for inclusion of the following items from the WATAE Biology papers (Year: Question No):

  1980: 9,11,27,29. 1981: 16,17,27. 1982: 3.

Examples of Item Uses

Essay framework

Item 1

Consider the following statement:

> Scientific research cannot be considered complete until it has been published or otherwise made available for appraisal by the scientific community.

Write an essay in which you critically examine this claim. Include an appraisal of each of the following statements, indicating whether you agree or disagree, and setting out clearly the basis of your agreement or disagreement.

A results of scientific work need to be made public to overcome the bias and distortion of individual judgment.
B any objections to a hypothesis are overcome once it has the support of other scientists.
C new discoveries, no matter how controversial, ought to be published in order to stimulate further research and scientific debate.
D the existing climate of scientific opinion is able to influence the direction of future research.

[Compare this item with item 17j-1]

Extended response

Item 2a

Races are sometimes described as a stage in the development of new species.

Discuss this statement by explaining how each of the following would or would not facilitate the formation of two new species from two existing races.

A reproductive isolation of members of one race from the other
B interbreeding between members of each race to produce fertile hybrid offspring
C increasing differences between members of each race leading to differing gene pools
D each race tending to be confined to geographical areas with differing environmental factors operating

[Compare this item with item 15j-5]

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Item 2b

The table shows a comparison of the levels of oxygen, carbon dioxide and nitrogen in blood. It also gives experimentally determined levels for the amount of each gas which can dissolve in the blood under body conditions.

	Oxygen (mL / 100 mL)	Carbon dioxide (mL / 100 mL)	Nitrogen (mL / 100 mL)
Amount present in arterial blood	20.0	50.0	1.70
Amount present in venous blood	14.0	56.0	1.70
Amount which could dissolve in blood under body conditions	0.40	2.96	1.04

From your understanding of the above information, and your knowledge of the blood transport system, write True (T) or False (F) after each statement.

The following statements are consistent with the information set out in the table above.

A Most of the oxygen and carbon dioxide carried in the blood is not in the form of dissolved gas molecules.

B Nitrogen is more soluble in blood than oxygen.

C Most of the oxygen in the blood is used up when the blood comes into close contact with the tissue cells.

D Tissue cells absorb oxygen and release an equivalent amount of carbon dioxide.

[Compare this item with item 11e-15]

In the space below **explain** why you judged each statement as True or False.

A

B

C

D

True/False

Item 3

Write True (T) or False (F) at the end of each of these statements.

The following statements are consistent with the cell theory.

A The cell is the unit of structure and function.

B Some structures are not cellular in form.

C All organisms consist of many cell types.

D All cells derive from pre-existing cells.

[Compare this item with item 9f-3]

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Debates

Item 4

It has often been said that the development of science, and the growth of scientific knowledge, over the past 300 years, has led to achievements which in many cases have been to the detriment of society and, in some cases, have threatened human existence. Out of concern for the issues raised by the results of scientific enterprise, several British scientists in 1969 formed a group known as the *British Society for Social Responsibility in Science*. This group argues that 'the development of science is not predetermined but should depend on the social choice of the community'.

Evaluate the following by discussing whether each statement is consistent or inconsistent with this argument.

A The development of science is affected more by political, economic and social pressures than by the aims and objectives of individual scientists.

B The development of science should depend more on recent discoveries and achievements than on the theories and principles established in the past 300 years.

C Scientists should become aware of the social significance of science and of their social responsibilities.

D The public should be made more aware of the implications and consequences of scientific development.

[Compare this item with item 16f-3]

Research stimulus

Item 5

The next 2 items refer to the following information:

The salt balance in the blood is controlled by anti-diuretic hormone (ADH). This hormone acts on the cells of the collecting ducts of the kidney making them more permeable to water and thereby allowing water to pass from the ducts into the surrounding blood supply. ADH is released in increasing quantities by the pituitary in response to changes in the salt balance of the blood.

One might expect ADH secretion to increase from the pituitary if there is

A dehydration.

B a drop in the salt to water ratio in the blood.

C blood loss.

D a rise in the osmotic pressure of the blood.

An increased output of urine could be expected from the following treatments.

A Injection into the blood of a substance that inhibits the action of ADH on the collecting ducts.

B Surgical removal of the pituitary.

C Injection of a strong salt solution into the blood supply of the pituitary.

D Constriction of the blood vessels leaving the pituitary.

Thoroughly research the above information and items, then (i) explain, and (ii) give evidence for, the acceptance or rejection of each alternative.

[Compare this item with items 12b-16 and 12b-17]

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